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IFORNIA—COLLEGE OF AGRICULTURE.
AGRICULTURAL EXPERIMENT STATION.

REPORT OF WORK

OF THE

AGRICULTURAL EXPERIMENT STATIONS

OF THE

UNIVERSITY OF CALIFORNIA,

For the Year 1890.

BY E. W. HILGARD,
Professor of Agriculture and Director of the Stations.

BEING A PART OF THE REPORT OF THE REGENTS OF THE UNIVERSITY.

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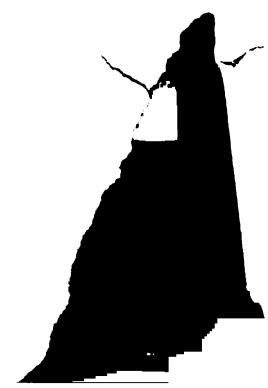

REPORT OF THE PROFESSOR OF AGRICULTURE AND DIRECTOR OF THE EXPERIMENT STATIONS

TO THE

PRESIDENT OF THE UNIVERSITY.

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LETTER OF TRANSMITTAL.

Prof. MARTIN KELLOGG, *Acting President of the University:*

SIR: I transmit herewith a report on the work of the Experiment Station of the University, including that of the culture sub-stations established under the provisions of the "Hatch Act" of endowment.

In the regular order of events this report should represent the work of the year 1890. Owing, however, to the difficulties and delays brought about by lack of an adequate *personnel* in the staff, and the extraordinary duties imposed upon the Director in the establishment of new culture sub-stations, it has been impossible to keep pace, in the publication of the annual reports, with the actual progress of the work. Hence, the present document contains the record of some work dating back as far as 1888, and thus far published only in bulletin form; and at the same time, owing to the lateness of the date at which it becomes possible to send this manuscript to press, it has seemed inadvisable to defer further the publication, in permanent form, of important material now on hand, but actually elaborated within the season of 1891. As a matter of fact, therefore, this report clears our docket of work done up to June 30, 1891, and not thus far published save partially in bulletin form, excepting only the viticultural work, which for palpable reasons is best published separately, as has been done heretofore. A report on this latter subject, prepared largely by Assistant Paparelli, will therefore follow the present one within a short time, and will similarly clear our docket up to the vintage of 1890, of which only a partial report can, in the nature of the case, as yet be made.

The increase lately made in the staff of the station, on the basis of the "College Aid Fund" provided at the last session of Congress, will render it possible to publish reports with regularity hereafter, so far as can be foreseen. It will always, however, be preferable to sacrifice the shadow to the substance, and to give publicity to subjects of immediate interest to the agricultural population whenever such matter shall be ready for the press. To do this in the definitive form of a final report would usually delay such publication to an undesirable extent; it is, therefore, intended to continue, as heretofore, the issuance of "bulletins" in transient form, which are to be reproduced, with more elaborate discussion when desirable, in the annual reports.

As regards the chemical work here reported, except where otherwise noted, that relating to soils, waters, and other mineral substances, as well as fertilizers, also that relating to ramie, beets, and greasewood, has been done by Assistant M. E. Jaffa; while all relating to fruits, and especially the analyses of musts and wines (separately reported upon hereafter) has been done by, or under the charge of, Assistant George E. Colby.

The arrangement and last revision of the body of the present report for the press has been in the experienced and efficient hands of Assistant Prof. R. H. Loughridge, whose former work in the report on cotton

production for the Tenth Census, vouches for his qualifications in the direction in which additional aid was most needed in this office. In the preparation of the entomological portion of the report, Assistant C. W. Woodworth has made important contributions, and we look forward with confidence to a material development of the entomological work of the station under his hands, already well trained and proved in former fields.

The wide and unusual scope taken by our station work is well illustrated in the present report. The large extent of territory, and the equally wide climatic range requiring our attention; the questions of immediate vital interest newly arising under unusual and imperfectly known conditions, necessarily impart to our work an aspect entirely different from that borne by the record of the stations whose work is thrown within the well-traced lines of climates akin to those of western Europe and the Atlantic States, where most of the theoretical investigation relating to agriculture has thus far been done, and laid down in standard publications. We cannot accept unquestioningly, for California, many of the maxims that have gained unhesitating assent in those regions, but whose application to arid climates has never had opportunity to be tested. The unfamiliar agricultural practice of South Spain, Egypt, North Africa, Asia Minor, and the northwest provinces of India, rather than that of the eastern United States, forms the basis upon which the greater part of California must build its own, profoundly modifying many of the current practices of the older States. The incredulity with which so many of the most familiar and daily occurring phenomena of Californian agriculture meet at the East (not uncommonly to the extent of being characterized as "another California yarn"), admonish us that our line of investigation is necessarily laid in different and new directions; and that while we should sedulously avail ourselves of every possible source of information afforded by Old World and Eastern practice, yet to follow such precedents blindly and without careful consideration of the characteristic differences induced by climatic influences, would be to court failure in the majority of cases.

If, therefore, Eastern or European readers should find the substance of this and of former reports of a rather miscellaneous and elementary character, and largely devoid of connected and systematic investigation, such as forms the subject of station work elsewhere, let it be remembered that California is not only a new country in the sense of comparatively late occupation by a progressive population, but that it also contains so much that is intrinsically new to scientific and technical investigation; that the problems to be solved by the experiment station are correspondingly new and untried, and must be dealt with accordingly.

E. W. HILGARD,
Director of Experiment Stations.

BERKELEY, July, 1891.

EXPERIMENT STATIONS OF THE UNIVERSITY OF CALIFORNIA.

CENTRAL STATION (Berkeley, Alameda County).

(NOTE.—All station officers participate in University instruction.)

E. W. HILGARD, Ph.D., LL.D. (Professor of Agriculture), Director and Chemist.

E. J. WICKSON, M.A. (Associate Professor of Agriculture, Horticulture, and Entomology), Superintendent of Agricultural Grounds.

E. L. GREENE, Ph.B. (Associate Professor of Botany), Botanist.

R. H. LOUGHRIDGE, Ph.D. (Assistant Professor), Agricultural Geologist and Agricultural Chemist.

M. E. JAFFA, Ph.B. (Instructor), First Assistant Chemist in Agricultural Laboratory.

L. PAPARELLI, Lic.Agr. (Instructor), Assistant in charge of Viticulture and Olive Culture.

GEORGE E. COLBY, Ph.B. (Instructor), Second Assistant Chemist in Viticultural Laboratory.

C. W. WOODWORTH, M.S. (Instructor), Assistant in Entomology.

W. G. KLEE (deceased), Inspector of Stations, to October 20, 1890.

C. H. SHINN, A.B., Inspector of Stations, from October 20, 1890.

EMIL KELLNER, Foreman of Station Grounds.

F. T. BIOLETTI, Foreman of the Viticultural Cellar.

E. F. GOODYEAR, Clerk to the Director (resigned June 30, 1891).

J. W. BLANKENSHIP, A.B., Clerk to the Director, from July 1, 1891.

SIERRA FOOTHILL STATION (near Jackson, Amador County).

A. CAMINETTI, Patron; Jackson (term expired June 30, 1891).

R. C. RUST, Patron; Jackson (appointed July 1, 1891).

GEORGE HANSEN, Foreman; Jackson.

SOUTHERN COAST RANGE STATION (near Paso de Robles, San Luis Obispo County).

J. V. WEBSTER, Patron; Creston.

R. D. CRUICKSHANK, Foreman; Paso Robles.

SAN JOAQUIN VALLEY STATION (near Tulare City, Tulare County).

B. F. MOORE, Patron; Tulare.

JULIUS FORRER, Foreman; Tulare.

SOUTH CALIFORNIA STATION (near Pomona, Los Angeles County).

RICHARD GIRD, Patron; Chino.

K. MCLENNAN, Foreman; Pomona.

VITICULTURAL STATIONS (under private auspices).

WEST SIDE SANTA CLARA VALLEY STATION; Cupertino, Santa Clara County. John T. Doyle, Patron; Menlo Park.

EAST SIDE SANTA CLARA VALLEY STATION; Mission San José, Alameda County. John Gallegos, Patron; Mission San José.

FRESNO VALLEY STATION; Fresno City, Fresno County. E. B. Rogers, Patron; Fresno.

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I.

RECORD AND DISCUSSIONS OF WORK IN THE GENERAL AGRICULTURAL LABORATORY.

EXAMINATIONS AND ANALYSES OF SOILS, WATERS, FRUITS, ALKALI, AND MISCELLANEOUS SUBSTANCES.

I. ANALYSES OF SOILS.

A. SIERRA FOOTHILLS.

Soils from the Foothill Experiment Station.

No. 1291. Soil from manzanita land, McKay tract, Foothill Station, Amador County; from the level, or gently sloping portion of the land beyond (west of) the Amador ditch, at the foot of a granite ridge. The land is covered thickly with large bushes of manzanita and spiny chaparral, with tufts of grass in open spaces. The soil is a fawn-colored, coarse, gritty loam; dry lumps crush easily, showing much coarse, angular sand, mainly granitic debris.

No. 1294. Soil from pine land, McKay tract, from lower slope of residence hill toward the ditch, overgrown with young pine and some manzanita bushes. A reddish, coarse, gritty loam, dry lumps crushing easily, becoming but slightly plastic on wetting and kneading, and showing much mica. The coarse part consists mainly of sharp quartz sand and larger quartz fragments, evidently derived from veins in the "bedrock;" also, more or less rounded fragments of a sandy, micaceous shale or slate, often rusty; little or no feldspar.

For comparison, two other soils of the station, already reported, are placed alongside.

Soils from the Foothill Station.

	No. 1291. Soil from Manzanita Land.		No. 1294. Soil from Pine Land.		No. 1115. Granite Soil, North Slope.		No. 1113. Slate Soil, South Slope.	
Coarse materials >0.5mm	52.00		23.00		40.00		19.20	
Fine earth	48.00		77.00		60.00		80.80	
	100.00		100.00		100.00		100.00	
Analysis of Fine Earth.								
Insoluble matter	72.43	81.37	73.52	79.77	62.44	73.95	49.96	64.92
Soluble silica	8.94		6.25		11.51		14.96	
Potash (K_2O)	.64		.26		.53		1.48	
Soda (Na_2O)	.09		.07		.18		.43	
Lime (CaO)	.20		.17		.50		.60	
Magnesia (MgO)	.18		.16		.30		2.21	
Br. ox. of manganese (Mn_3O_4)	.03		.04		.04		.05	
Peroxide of iron (Fe_2O_3)	4.19		4.67		5.28		11.52	
Alumina (Al_2O_3)	8.63		9.35		12.18		12.81	
Phosphoric acid (P_2O_5)	.05		.07		.05		.05	
Sulphuric acid (SO_3)	.01		.01		.01		.02	
Water and organic matter	4.89		5.24		7.28		6.63	
Totals	100.28		99.81		100.30		100.22	
Humus	.412		.392		.48		.54	
Ash	.518		.358		.23		.80	
Sol. phosphoric acid	.020		.018		.02		.03	
Silica	.240		.130		.16		.60	
Hygroscopic moisture (absorbed at 15° C.)	2.56		3.14		5.93		5.74	

The above table shows very wide differences in the composition of the soils of the station in its several portions. All agree in having but a moderate supply of phosphoric acid; but in potash they range all the way from .26 to 1.48 per cent; in lime from .17 to .60 per cent (in the subsoil of No. 1113, 1.37 per cent). It is thus no wonder that without a close examination of the soils to be used, agricultural ventures in the foothills are sometimes disappointing; both because of great differences in the nature of the soils within small distances, and of the variations in depth. In addition, the so called granites differ so widely in their mineral nature that what is true of one "granite soil" may not be at all true of another in a different region.

Of the two soils here specially in question, it appears that they constitute the poorest portion of the station tract; and hence the fertilizer experiments made upon them this year (1891) will be of more than usual interest, it being currently stated that they do not yield, at best, more than one and a quarter to one and a half tons of hay per acre, and in unfavorable years much less. The kind of fertilizer wanted on them will probably be found to be of the most complete type—that of stable manure.

No. 1139. Red soil of the foothills, Sec. 7, T. 17 N., R. 14 E., near Moore's Station, on the Oroville road, Butte County; sent by Mr. Norman Rideout, Marysville. The sample was taken twelve inches deep.

"The soil is taken from a hillside in the foothills, on the east side of the Sacramento Valley, at an elevation of about five hundred feet above the level of the sea. The soil is covered with a short grass which, during the winter and spring, affords an excellent pasture; and in this neighborhood such land is generally used for this purpose only. It is

well covered with trees, consisting of white oak, with an occasional digger pine. The soil, when plowed and exposed to the sun and air, assumes a bright red color, which becomes darker with cultivation. It packs quickly, but this difficulty seems to be overcome by repeated plowing. The soil is deep, and it is difficult to distinguish any subsoil; however, there seems to be more gravel at the surface. The average rainfall is twenty inches. Attention is being directed to this land as suitable for the vine, olive, and fig. Large numbers of trees and vines have been planted, and, with irrigation, appear to be doing well. The sample is a fair average one of a soil covering thousands of acres in the foothills, on the eastern border of the Sacramento Valley."

A cinnamon-colored, silty loam. The dry lumps crush pretty easily between the fingers, soften quickly on wetting, without greatly darkening in color, and become only moderately plastic on kneading. The soil will evidently till kindly, save when *very* wet. It contains some coarse sand and (mostly angular) gravel up to one fourth inch diameter, consisting partly of white quartz, but mostly of gray sandstone, and other sandy varieties of the foothill "bedrock." It does not effervesce with acids.

The analysis resulted as follows:

Red Lands near Moore's Station, Butte County.

	No. 1139. Red Soil.	
Coarse materials >0.5mm	35.00	
Fine earth	65.00	
Analysis of Fine Earth.		
Insoluble matter	47.27	65.54
Soluble silica	18.27	
Potash (K_2O)	.26	
Soda (Na_2O)	.05	
Lime (CaO)	6.10	
Magnesia (MgO)	1.23	
Br. ox. of manganese (Mn_3O_4)	.03	
Peroxide of iron (Fe_2O_3)	9.84	
Alumina (Al_2O_3)	12.35	
Phosphoric acid (P_2O_5)	.07	
Sulphuric acid (SO_3)	.01	
Water and organic matter	4.42	
Total	99.90	
Humus	.35	
Ash	.44	
Sol. phosphoric acid	.03	
Silica	.28	
Hygroscopic moisture (absorbed at 15°C.)	4.00	

The analysis shows this soil to be quite poor in potash and humus, but with a fair proportion of phosphoric acid, and a large one of lime; the latter substance, however, is not in the form of carbonate to any great extent, but, as shown in the higher proportion of soluble silica in this and other foothill soils, in that of an easily decomposable complex silicate. The soil is thus not a very thrifty one, and would soon be exhausted by field crops, but where deep enough will doubtless do well for fruits, especially peaches, almonds, cherries, citrus fruits, and others requiring light and well drained soils. For citrus fruits and grapes it would soon require fertilization with potash salts, and, ultimately, with complete fertilizers. Its low content of humus should, as soon as possi-

ble, be increased by green-manuring, or, if fruits should prove undersize, by the use of Chile saltpeter or other nitrogenous fertilizers.

Nos. 1027, 1028. Red soil and subsoil, from eight miles west of Anderson, Shasta County; sent by Mr. J. R. Love, Anderson. The dry lumps crush readily between the fingers, and when wet are of a dark red color, and plastic to some extent. The difference between the soil and its subsoil seems to be chiefly in the organic matter, which gives to the soil a darker color; the humus and its available constituents were therefore alone determined in the soil, and a full analysis given to the subsoil.

Red Land west of Anderson, Shasta County.

	No. 1028. Red Subsoil.		No. 1027. Red Soil.
Coarse materials > 0.5mm	23.3		
Fine earth	76.7		
	100.0		
Analysis of Fine Earth.			
Insoluble matter	51.893	69.741	
Soluble silica	17.848		
Potash (K_2O)	.273		
Soda (Na_2O)	.162		
Lime (CaO)	.113		
Magnesia (MgO)	.306		
Br. ox. of manganese (Mn_3O_4)	.026		
Peroxide of iron (Fe_2O_3)	6.979		
Alumina (Al_2O_3)	15.801		
Phosphoric acid (P_2O_5)	.041		
Sulphuric acid (SO_3)	.033		
Water and organic matter	7.447		
Total	100.922		
Hygroscopic moisture (absorbed at 15° C.)	8.347		8.000
Humus			1.614
Ash			.328
Soluble phosphoric acid			.020

This soil is rather unusual in composition for California, and would readily be taken, in its chemical composition, for one of the "Pine Hill" soils of the Cotton States. Its supply of lime is the lowest thus far found in any soil of this State, and would be deficient anywhere; phosphoric acid and potash are also in low supply, and considering the poverty in lime, this soil cannot be considered as likely to produce for more than a few years without substantial fertilization. The large percentage of alumina is evidently due to the presence of "clay," but the latter is not in a plastic condition, but probably in that of kaolin or porcelain earth—a poor foundation for a soil.

So long as so much good land can be had in the State, few will care to cast their lot on such land as this.

No. 1179. Soils from the east side of Honey Lake, Lassen County; sent by W. A. Clark, Berkeley. The samples were taken twelve inches deep, and represent a district of thirty square miles more or less accurately. They are whitish, silty, effervescent with acid, becoming somewhat plastic on wetting, without darkening much in color. The coarser parts are sharply angular, apparently fragments of obsidian (volcanic glass) and pumice stone, with some quartz. All the samples appear to be ancient lake deposits. Only one was chemically examined.

Soil from Honey Lake, Lassen County.

	No. 1179. East Side of Lake.
Potash	.85
Soda	.49
Lime (8.54 carbonate of lime)	4.78
Phosphoric acid	.12
Sulphuric acid	.03

These data show the soil to be highly calcareous, and rich both in potash and phosphoric acid. All are evidently poor in humus, and in the absence of definite information regarding the vegetation of the lands, it is difficult to judge how far they would be productive in cultivation without the addition of vegetable matter. So far as the mineral ingredients are concerned they promise well, although the large proportion of soda found indicates the presence of some "alkali." Much will, of course, depend upon the nature of the subsoil, which, in some of these lands, is known to be extremely sandy, and of little promise. Such tracts are usually marked by an exclusive growth of greasewood; the addition of gray sage to this vegetation always proves the presence of a more substantial subsoil, which is of particular importance in lands to be irrigated.

B. GREAT VALLEY.

No. 1192. Soil from the land of the Buhach Colony, Merced; sent by McSwain & Co., Merced. The soil is a sandy loam, somewhat dark when dry. Its subsoil is much lighter in color, and closely resembles the under-subsoil, an analysis of which is given below. The soil sample was taken to a depth of six inches.

No. 1194. Under-subsoil of the above; taken at a depth of from thirty to fifty-four inches. It is light gray in color when dry, very sandy.

Valley Land, Buhach Colony, Merced.

	No. 1192. Soil.		No. 1194. Under-subsoil.	
Coarse materials >0.5mm	35.00		30.00	
Fine earth	65.00		70.00	
Analysis of Fine Earth.				
Insoluble matter	90.30	92.67	88.69	91.25
Soluble silica	2.37		2.56	
Potash (K_2O)	.26		.25	
Soda (Na_2O)	.08		.06	
Lime (CaO)	.49		.41	
Magnesia (MgO)	.33		.34	
Br. ox. of manganese (Mn_3O_4)	.03		.03	
Peroxide of iron (Fe_2O_3)	3.32		3.67	
Alumina (Al_2O_3)	1.87		2.95	
Phosphoric acid (P_2O_5)	.03		.03	
Sulphuric acid (SO_3)	.03		.02	
Water and organic matter	1.27		.87	
Totals	100.38		99.88	
Humus	.29			
Ash	.34			
Sol. phosphoric acid	.02			
Silica	.17			
Hygroscopic moisture (absorbed at 15° C.)	1.08		1.28	

These soils are extremely sandy, and at first sight would seem to correspond with the sandhill soils of the Fresno neighborhood. But examination shows that the sand of the Merced soils is very largely granitic, and, correspondingly, the analysis shows higher proportions of mineral plant-food, and, therefore, a better promise of durability. It will be observed that there is no notable difference between the subsoil at four and one half feet depth and the surface soil; the former is slightly heavier and more retentive. Considering the great depth and perviousness of the soil and subsoil, the low plant-food percentages need not discourage cultivation, so long as the level of the bottom-water is not allowed to rise too near the surface; but to fill up this land with water from below will be just as fatal to its production as it has been to that of the sandier class of soils near Fresno. The application of manures, when called for, will require careful management, as fresh stable manure would not decay, and therefore would remain ineffective, unless put in very deeply; while soluble fertilizers would very readily be washed out of reach of the roots of crops by heavy rains, or irrigation.

No. 1061. *Soil* of viticultural experimental plot for grafting; E. B. Rogers' place, Fresno. The sample was taken twelve inches deep. This is a coarsely sandy, reddish soil, showing an abundance of angular granitic ingredients; some little angular as well as partly rounded gravel, as much as eight mm. in diameter. The dry lumps crush easily between the fingers; on wetting they soften quickly and become slightly plastic; but the soil should be workable at all times. When dry the color is reddish brown, mottled with white grains; wetting heightens the reddish tint.

No. 1063. *Subsoil* of the above; taken from twenty-four to thirty-six inches depth. A brownish, sandy, lumpy mass, almost a hard pan, probably from sampling while wet. The dry lumps do not crush readily between the fingers, but soften instantly on wetting and become fairly plastic. This substratum manifestly contains more clay than the surface soil, for which it makes a very substantial foundation; it contains less of coarse and gravelly ingredients than the soil.

No. 1065. *Subsoil* of land offered for an experimental plot on Dr. Eschleman's place, three miles east of Fresno. The sample was taken from twelve to twenty-four inches depth. It does not differ materially from the soil in any respect, save in a slightly lighter color. The soil is a very sandy loam, somewhat coarse, and showing many white grains of one and two mm. diameter, which, under the microscope, are shown to be quartz and feldspar. The dry lumps are somewhat coherent, but are readily crushed between the fingers; the soil is barely plastic on wetting.

No. 1066. *Under-subsoil* of the above; Dr. Eschleman's place. Taken at a depth of four to four and a half feet. The earth is very similar to the surface soil, save as to a still lighter tint and slightly greater coarseness.

Valley Land of Experimental Plots, near Fresno.

	E. B. Rogers' Place.		Dr. Eschleman's Place.	
	Soil. No. 1061.	Subsoil. No. 1063.	Subsoil. No. 1065.	Under-subsoil. No. 1066.
Coarse materials >0.5mm	44.5	25.5	14.5	15.35
Fine earth	55.5	74.5	85.5	84.65
	100.0	100.0	100.0	100.00
Analysis of Fine Earth.				
Insoluble matter	73.511	69.170	83.30	85.56
Soluble silica	11.289 } 84.800	13.498 } 82.668	6.31 } 89.61	3.70 } 89.26
Potash (K_2O)	.418	.654	.29	.35
Soda (Na_2O)	.530	.762	.47	.26
Lime (CaO)	1.417	.975	1.02	1.00
Magnesia (MgO)	1.955	2.881	.63	.71
Br. ox. of manganese (Mn_3O_4)	.068	.157	.05	.02
Peroxide of iron (Fe_2O_3)	4.995	5.178	2.70	3.57
Alumina (Al_2O_3)	4.268	5.122	4.27	3.67
Phosphoric acid (P_2O_5)	.028	.040	.02	.04
Sulphuric acid (SO_3)	.016	.025	.01	.02
Water and organic matter	1.864	2.239	1.00	1.06
Totals	100.359	100.701	100.07	99.96
Humus	.281			.08
Ash	.082			.10
Sol. phosphoric acid	.004			
Hygroscopic moisture	2.21	4.07	1.41	1.31
Absorbed at	15° C.	15° C.	16° C.	15° C.

It will be noted that these two soils, and their subsoils, differ as materially in their composition as in their aspect. The reddish soil of Rogers' place is very much more substantial than that from the Eschleman tract, which appears to have been originally a sandy wash, lying a good deal lower than the reddish soil. The latter is manifestly derived directly from the Sierra granite, which, as the high percentage of "soluble silica" shows, has been to a large extent disintegrated into more soluble forms; and while both soils alike are fairly calcareous, the red soil is richer in potash, and possesses a substantial subsoil that retains moisture well, a quality in which the soil of the lower ground is notably deficient. Both are rather poor in phosphates, and there can be no doubt that this deficiency will be the first to be felt, and require to be dealt with as cultivation progresses. Both soils also are poor in humus, and should be supplied with vegetable matter for greater retentiveness and better supply of nitrogen. Their great depth and perviousness of course makes up for the relatively low supplies of plant-food in these soils, so long as the water-level is kept below the reach of the roots.

No. 1055. Red soil of Fresno Plains, Sec. 9, T. 14 S., R. 19 E., nine miles west of Fresno; from M. Theo. Kearney's "Fruitvale" tract. Taken to a depth of twenty-four inches. The soil is quite sandy, reddish when moist, and grayish brown when dry; could be tilled at all times. It contains visible white specks of potash feldspar (orthoclase); at some points these are very abundant and large. On washing the soil yields about 65 per cent of materials coarser than one mm. hydraulic value, glistening with black and golden mica (biotite), and containing a large amount of coarse quartz and orthoclase (apparently no plagio-

clase). This tract is free from "hog-wallows," and bears the usual "plains" vegetation. It lies north of the Fresno "white ash" lands, toward the San Joaquin River; the "white ash" soil is doubtless connected with the Kings River drainage, the other with that of the San Joaquin River.

Land of Fresno Plains, "Fruitvale" Tract.

	No. 1055. Red Soil.	
Coarse materials >0.5mm	9.00	
Fine earth	91.00	
	100.00	
Analysis of Fine Earth.		
Insoluble matter	67.34	78.91
Soluble silica	11.57	
Potash (K_2O)	.82	
Soda (Na_2O)	.20	
Lime (CaO)	1.14	
Magnesia (MgO)	1.58	
Br. ox. of manganese (Mn_3O_4)	.02	
Peroxide of iron (Fe_2O_3)	7.51	
Alumina (Al_2O_3)	6.30	
Phosphoric acid (P_2O_5)	.07	
Sulphuric acid (SO_3)	.01	
Water and organic matter	3.28	
Total	99.84	
Humus	.39	
Ash	.23	
Sol. phosphoric acid	.03	
Silica	.17	
Hygroscopic moisture (absorbed at 15° C.)	3.62	

It will be seen that this soil differs quite materially from all the soils of the immediate neighborhood of Fresno thus far examined, the only point of agreement being a similar proportion of lime. But it is materially richer in both potash and phosphoric acid, and in its general composition is exceedingly like the lands of the Mussel Slough region in Tulare County, differing from the latter only in containing a little more iron. It will no doubt prove similarly productive when irrigated, and will be less subject to the invasion of alkali. Its supply of humus is not high, and hence, on cultivation, the addition of vegetable matter by green-manuring, or the use of nitrogenous fertilizers, would probably be first called for.

No. 1189. Soil from Sec. 17, T. 12 S., R. 17 E., near Madera, Fresno County; sent by Mr. John Brown, Madera. This is a gray, silty soil, full of glistening mica scales and fine sand. It darkens a little on wetting, and becomes but slightly plastic on kneading. The natural grasses are bunch grass and alfilerilla; also, a weed commonly called "turpentine-weed" (*Trichostema*). The sample was taken to a depth of twelve inches from the surface, though there was no apparent change for thirty inches.

No. 1190. Soil from Sec. 28, T. 12 S., R. 17 E., Fresno County; sent by Mr. John Brown, Madera. This is a gray, sandy soil; the dry lumps are easily crushed between the fingers; becomes but very slightly plastic on kneading, and darkens considerably on wetting. The natural grasses are bunch grass, alfilerilla, and "salt grass." The sample was

taken to a depth of twelve inches from the surface; at fourteen inches there is a heavy, sandy subsoil.

No. 1191. Soil from Sec. 15, T. 12 S., R. 17 E., Fresno County; sent by Mr. John Brown, Madera. The soil is dark in color, and its dry lumps are hard to crush between the fingers; it becomes quite plastic on wetting, and darkened considerably. It contains some specks of bog ore. It would not be tillable in wet weather. The natural grasses are bunch grass, salt grass, and turpentine-weed. The sample was taken to a depth of twelve inches from the surface; below fifteen inches the subsoil is sandy and light colored.

Soils from Madera, Fresno County.

	No. 1189. Sec. 17, T. 12 S., R. 17 E. Soil.		No. 1190. Sec. 28, T. 12 S., R. 17 E. Soil.		No. 1191. Sec. 15, T. 12 S., R. 17 E. Soil.	
Coarse materials>0.5mm	15.85		7.00		5.00	
Fine earth	84.15		93.00		95.00	
	100.00		100.00		100.00	
Analysis of Fine Earth.						
Insoluble matter	65.79	77.83	73.31	84.04	52.88	71.14
Soluble silica	12.04		10.73		18.26	
Potash (K_2O)	1.32		.67		1.01	
Soda (Na_2O)	.14		.23		.22	
Lime (CaO)	.99		1.31		1.10	
Magnesia (MgO)	1.54		1.74		1.28	
Br. ox. of manganese (Mn_3O_4)	.02		.03		.02	
Peroxide of iron (Fe_2O_3)	6.65		4.09		7.78	
Alumina (Al_2O_3)	7.73		3.97		9.52	
Phosphoric acid (P_2O_5)	.06		.16		.08	
Sulphuric acid (SO_3)	.01		.05		.01	
Water and organic matter	3.62		3.67		7.58	
Totals	99.91		99.96		99.74	
Humus	.88		1.08		2.32	
Ash	.52		.74		1.03	
Sol. phosphoric acid	.02		.03		.02	
Silica	.47		.06		.89	
Hygroscopic moisture (absorbed at 15° C.)	2.73		3.84		7.02	

These fall within the limits of good, thrifty soils, without extreme physical character, and therefore adapted to a great variety of cultures. The most substantial is No. 1191, but from its appearance it seems not to be well drained, and is therefore recommended for figs, apricots, etc., rather than for grapes. No. 1190 ought to be good grain as well as fruit land; while No. 1189, being light in phosphoric acid and high in potash, and rather disposed to be droughty, is best adapted to grapes.

C. COAST RANGE.

No. 1029. Shell soil from Bay Island Farm, Alameda County; sent by John O. Titlow, San Francisco.

"The land seems to be of drift material for from three to five feet deep; then a layer of sand of six inches, underlaid by hardpan."

The soil contains much visible shell debris mixed with dark mold and some sand; in handling it the fingers become blackened. On wetting it hardly shows any adhesiveness, but becomes sooty black.

Soil of Bay Island Farm, Alameda County.

	No. 1029. Shell Soil.	
Coarse materials >0.5mm (mostly shells)	40.22	
Fine earth	59.78	
	100.00	
Analysis of Fine Earth.		
Insoluble matter	69.94	73.47
Soluble silica	3.53	
Potash (K_2O)	.28	
Soda (Na_2O)	.32	
Lime (CaO)	8.21	
Magnesia (MgO)	.43	
Br. ox. of manganese (Mn_3O_4)	.08	
Peroxide of iron (Fe_2O_3)	1.76	
Alumina (Al_2O_3)	2.66	
Phosphoric acid (P_2O_5)	.70	
Sulphuric acid (SO_3)	.16	
Carbonic acid (CO_2)	5.20	
Water and organic matter	6.51	
Total	99.77	
Humus	4.26	
Ash	.49	
Hygroscopic moisture (absorbed at 15°C.)	5.67	

This soil is naturally very rich in lime, and extraordinarily so in phosphoric acid, exceeding in this respect any soil thus far known to me; it is, of course, derived from the animal matter, fish bones, etc., which have gone into the shell bed. In potash the soil is not rich, but under the circumstances of its formation the amount present is probably very largely available; yet potash will doubtless be the first substance required when fertilization shall be needed. Its content of humus is unusually large.

This land is hardly well adapted to general fruit culture, but should yield high returns in vegetables, grain, or forage plants. Of orchard fruits, plums, figs, and quinces would probably suit the conditions best, and melons will doubtless do finely.

This soil is quite like that of the "shell hammocks" of the Gulf States.

No. 999. Soil from hillside near Wright's Station, Santa Clara County, three and one half miles west of New Almaden quicksilver mines; sent by Mr. C. C. Poppe, Wright's Station. This is a sienna-brown loam; the clods are hard to crush between the fingers; it darkens considerably on wetting, and is somewhat plastic; it is mixed with a good deal of coarse sandy and rocky material. The vegetation is manzanita, small oak, and chaparral bushes. The elevation of the land is about fifteen hundred feet above the level of the sea.

No. 1000. Soil from hillside three and one half miles west of New Almaden quicksilver mines, Santa Clara County; sent by Mr. C. C. Poppe, Wright's Station. The land faces directly north, and is covered with large oak, poison oak, and pepperwood. It is a loose, dark blackish soil, abundantly mingled with angular rock fragments. On wetting it darkens to almost black, and becomes highly plastic; it has but little sand; on handling it easily yields a blackish dust and colors the fingers.

Soils from Wright's Station, Santa Clara County.

	No. 999. Hillside Soil.		No. 1000. Hillside Soil.
Coarse materials >0.5mm	47.00		
Fine earth	53.00		
	100.00		
Analysis of Fine Earth.			
Insoluble matter	21.53	46.55	
Soluble silica	25.02		
Potash (K_2O)	.31		
Soda (Na_2O)	.26		
Lime (CaO)	1.39		
Magnesia (MgO)	16.97		
Br. ox. of manganese (Mn_3O_4)	.04		
Peroxide of iron (Fe_2O_3)	18.58		
Alumina (Al_2O_3)	4.91		
Phosphoric acid (P_2O_5)	.11		
Sulphuric acid (SO_3)	.02		
Water and organic matter	11.74		
Total	100.88		
Humus	2.75		9.86
Ash	1.40		1.01
Sol. phosphoric acid	.04		.11
Hygroscopic moisture (absorbed at 15° C.)	10.47		10.33

The red soil, No. 999, which is evidently somewhat refractory in tillage, is of very unusual composition, in the extraordinary amounts of magnesia and iron contained in it. The former points to its derivation from some of the serpentinous rocks of the region, which accounts also for its poverty in potash. It has, however, good supplies of lime and phosphoric acid, and an unusually high percentage of humus. The latter condition is exaggerated in the hillside soil, No. 1000, which is manifestly one of the characteristic "redwood soils," noted for their profuse productiveness; although, in such a case as this, better adapted to vegetables than fruit. In the latter direction the red soil is doubtless preferable, and with good cultivation will yield excellent results. The high percentage of readily soluble phosphoric acid promises high and lasting productiveness; but potash manures will probably be necessary before many years under heavy cropping with fruit, especially in the case of grapes. The remarkably high absorption of moisture promises good security against damage from drought or hot winds.

No. 1075. Soil, from cañon in Chile's Valley, Napa County; sent by Mr. F. Sievers, San Francisco. The soil is a yellowish-gray loam, quite light and easily tilled; the subsoil is slightly effervescent with acids, and heavier, yet not refractory. The sample was taken to a depth of twelve inches.

No. 1077. Soil, from the hillside bordering Chile's Valley, Napa County; sent by Mr. F. Sievers, San Francisco. The soil is a yellow or fawn-colored adobe, brown when dry, and barely yields to the finger; it is moderately stiff when wet. It is underlaid at three feet by a very stiff subsoil. The sample was taken at twelve inches depth.

Soils of Chile's Valley, Napa County.

	No. 1075. Cañon Soil.		No. 1077. Hillside Adobe Soil.	
Coarse materials >0.5mm	4.00		21.00	
Fine earth	96.00		79.00	
	100.00		100.00	
Analysis of Fine Earth.				
Insoluble matter	60.26	74.85	33.89	62.03
Soluble silica	13.59		28.14	
Potash (K_2O)	1.48		.67	
Soda (Na_2O)	.41		.75	
Lime (CaO)	.30		2.49	
Magnesia (MgO)	1.43		10.77	
Br. ox. of manganese (Mn_3O_4)	.05		.19	
Peroxide of iron (Fe_2O_3)	6.97		10 22	
Alumina (Al_2O_3)	10.85		7.38	
Phosphoric acid (P_2O_5)	.08		.08	
Sulphuric acid (SO_3)	.01		.03	
Water and organic matter	4.85		5.84	
Totals	100.28		100.45	
Humus	.59		.82	
Ash	.70		.40	
Sol. phosphoric acid	.03		.02	
Hygroscopic moisture (absorbed at 16½° C.)	6.38		7.22	

These two soils differ widely in composition in most respects, the valley soil being very rich in potash and poor in lime, while the other is strongly calcareous, with but a moderate yet quite adequate supply of potash. The high figure for magnesia indicates the derivation of this soil from some of the "soapstone" or magnesian shales that occur so frequently in the Coast Range. Phosphoric acid is in only moderate supply in both, but in the valley soil much of it is in the soluble form; still, phosphates will here as elsewhere probably be the first fertilizer required when the soils' production slackens. The supply of humus is only fair in the valley soil, and should be supplemented by green-manuring. The character and great depth of the valley soil render it specially adapted to general fruit culture.

No. 880. Tule soil, from inside of the levee on Grizzly Island, Sacramento County; sent by Mr. Warren Dutton, Dutton's Landing. The soil is a grayish silt with very little grit; becomes just a little adhesive when wetted. At the top it is penetrated with the roots of alkali grass. On a freshly-cut surface it is somewhat marbled blue and yellow, with dots of bog ore; it crushes between the fingers.

The soil (No. 881) on the outside of the levee is blackish and more clayey than the above, and its dry clods cannot be readily crushed between the fingers. It contains 6.86 per cent of moisture, air-dried, and 22.26 per cent of organic matter.

The inside soil, whose analysis is given below, consists almost entirely of fine earth.

Tule Soil, Sacramento County.

	No. 880. Grizzly Island Soil.	
Analysis of Fine Earth.		
Insoluble matter	50.46	65.48
Soluble silica	15.02	
Potash (K_2O)	.65	
Soda (Na_2O)	.44	
Lime (CaO)	.71	
Magnesia (MgO)	1.71	
Br. ox. of manganese (Mn_3O_4)	.07	
Peroxide of iron (Fe_2O_3)	6.92	
Alumina (Al_2O_3)	13.43	
Phosphoric acid (P_2O_5)	.08	
Sulphuric acid (SO_3)	.18	
Water and organic matter	10.16	
Total	99.83	
Humus	1.95	
Ash	.47	
Hygroscopic moisture (absorbed at 15° C.)	10.96	

This soil certainly seems to be worthy of reclamation by drainage, if such has not already been done when its levees were built. There is a large percentage of potash present, with a fair amount of phosphoric acid; while any sourness or acidity that might arise from its large content of organic matter will be neutralized by its lime and magnesia.

No. 1230. Soil of the "sand hills," six miles east of Antioch, and three miles northwest of Brentwood; sent by L. L. Guss, Wrights, Contra Costa County. "The land is nearly level, and is covered with chaparral brush. There are some almond trees in bearing on land of this character, and they yield enormously, but the trees make very little growth; the sand is loose enough to drift when plowed. The sample was taken to the depth of fourteen inches."

Sand Hills Soil, Contra Costa County.

	No. 1230. Sand Hills Soil.	
Coarse materials >0.5^{mm}	5.00	
Fine earth	95.00	
	100.00	
Analysis of Fine Earth.		
Insoluble matter	88.07	92.04
Soluble silica	3.97	
Potash (K_2O)	.24	
Soda (Na_2O)	.09	
Lime (CaO)	.66	
Magnesia (MgO)	.34	
Br. ox. of manganese (Mn_3O_4)	.02	
Peroxide of iron (Fe_2O_3)	3.41	
Alumina (Al_2O_3)	1.89	
Phosphoric acid (P_2O_5)	.06	
Sulphuric acid (SO_3)	.02	
Water and organic matter	1.28	
Total	100.05	
Humus	.33	
Ash	.46	
Sol. phosphoric acid	.02	
Silica	.13	
Hygroscopic moisture (absorbed at 15° C.)	3.94	

In view of the extreme sandiness of the soil (92.04 of sand, etc.), it is very well supplied with plant-food, and if of sufficient depth, should prove very productive of fruit, at least, and anything else that has deep roots. It would not last long for grain; peaches and almonds, and grapes for wine, would be its special adaptation if the climate permits; but the depth of the soil above bedrock should not be less than eight or ten feet.

No. 1178. Tule soil, from marsh meadows at the mouth of Eel River, Humboldt County; sent by G. H. Kellogg, of San Francisco. This is a light gray soil, of a silty character, much netted with tule roots, whose course is marked by rusty streaks, while rust spots also appear here and there. The dry lumps crush with difficulty between the fingers; they soften quickly and darken in color on wetting, and become slightly plastic on kneading. No coarse sand or gravel is present.

Tule Soil, Humboldt County.

	No. 1178. Mouth of Eel River Soil.	
Coarse materials >0.5mm	5.00	
Fine earth	95.00	
	100.00	
Analysis of Fine Earth.		
Insoluble matter	51.33	58.49
Soluble silica	7.16	
Potash (K_2O)	.34	
Soda (Na_2O)	.32	
Lime (CaO)	2.06	
Magnesia (MgO)	4.39	
Br. ox. of manganese (Mn_3O_4)	.05	
Peroxide of iron (Fe_2O_3)	9.56	
Alumina (Al_2O_3)	6.04	
Phosphoric acid (P_2O_5)	.13	
Sulphuric acid (SO_3)	.38	
Water and organic matter	17.98	
Total	99.74	
Humus	1.71	
Ash	.17	
Sol. phosphoric acid	.04	
Hygroscopic moisture (absorbed at 15° C.)	11.64	

Common salt, .083 per cent, was obtained by leaching the soil.

This soil is evidently not greatly subject to tidal overflow, as it contains so little of the sea salt that otherwise would form an obstacle to its cultivation. In its chemical composition it shows good proportions of lime, phosphoric acid, and humus; but no very large amount of potash, albeit the latter would not be found deficient for some time. The land will, doubtless, if properly drained, yield full crops of grain or hay for a number of years, and for the present would not seem to require any liming, as is so commonly necessary in marshes elsewhere.

D. SOUTH CALIFORNIA.

SOILS OF THE SOUTH CALIFORNIA STATION.

The establishment of a culture sub-station for South California, on land situated not far from Pomona, but within the limits of the Chino Ranch, was announced in the "Report to the President of the University" for 1890. Considerable progress has been made in the equipment and planting of this station, although the funds available for the purpose were materially below what could have been desired; since it was necessary to maintain the three stations already established, and to start and equip the fourth, within the limits of the sum which will barely suffice to "run" all four when once fully equipped. Some data regarding the progress made will be found in the report of the Inspector, Mr. Shinn, in another portion of this report. It is intended, so soon as the equipment and occupation of the South California Station shall be completed, to render a report on it and on the region it is intended to represent, as far as possible on the same plan pursued in a former publication treating of the other stations; including, therefore, as full a description of the physical and agricultural features of South California as the data at command will permit. As this report cannot be written until some time in 1892, some of the work done in that section since the last general report was published, will be reported upon in the present publication, for the more prompt information of the population interested.

The South California Station tract comprises two plots of land, situated about two miles apart, both donated by Mr. Richard Gird, from land of the Chino Ranch. The main tract of thirty acres is on the northern line of that ranch, about two miles from Pomona and two and one half miles from Chino town. On it are located the station house and other improvements, the expense of the buildings having been provided for by subscription among the citizens of Pomona; while the water supply, at the rate of one inch for each ten acres, was also donated by Mr. Gird. The soils of this tract comprise about five sixths of "red mesa" land, such as has proved specially appropriate for the culture of citrus fruits; while the rest represents the gray, gravelly soil that characterizes the "washes" from the Sierra Madre. It is on this tract, of course, that the main plantation of fruit trees has been made. Water is found in this land at from forty-five to sixty feet depth, in gravel.

The other tract, of ten acres, lies about two miles to southward of the first, and forms part of the wide belt of "moist lands" which border Chino Creek and require no irrigation, and are considered as more specially adapted to field crops. Water is here found at twelve to fifteen feet. This tract is within half a mile of the Chino townsite and about four miles from the town of Pomona.

The soils examined represent the main body of the land of both tracts, so far as single specimens can do so; a more detailed examination will be made hereafter.

No. 1281. Surface soil, taken near the center of the main tract of the station, to twelve inches depth. It is a reddish gray or fawn-colored, sandy loam; the dry lumps fall to pieces readily, and show much sand, some coarse, up to one eighth inch diameter. The sand grains are mostly granular, colorless quartz, with much feldspar, black grains of augite, as well as of hornblende and some garnet, occasionally

mbedded in fragments of chlorite schist. These minerals prove the derivation of the soil from the head of the San Bernardino Valley, as against the gravelly "wash" soil, which contains only the granitic minerals of the Sierra Madre, where it is drained by San Antonio Creek. The soil when wetted darkens slightly and becomes slightly plastic, but not adhesive. The vegetation on this land is predominantly the sunflower, of small size because of dryness, a little blue sage, short grass, spinous-leaved gilias (*G. filifolia, attractiloides*), and turkey-weed (*Eremocarpus setigerus*).

No. 1282. Subsoil, taken from twelve to twenty-four inches depth; it is quite similar to the soil, but a little more clayey and compact.

No. 1284. "Adobe" soil from the moist lands bordering Chino Creek; taken to twelve inches depth. A mouse-colored, moderately clayey loam, somewhat silty; the dry lumps crush quite readily between the fingers, and show little or no grit. With acid there is effervescence; on wetting, the color deepens considerably, and when kneaded the soil becomes quite adhesive, showing that it must not be tilled while wet. Its natural vegetation is a dense, tall growth of grass, with some spots bearing the "Yerba mansa" (*Anemopsis Californica*) and sunflower.

Soils from South California Station.

	Center of Main Tract—Mesa or "Dry Land."		South Plot—"Moist Land."
	No. 1281. Soil.	No. 1282. Subsoil.	No. 1284. Soil.
Coarse materials>0.5mm	10.00	11.00	1.00
Fine earth	90.00	89.00	99.00
	100.00	100.00	100.00
Analysis of Fine Earth.			
Insoluble matter	67.98	70.46	62.62
Soluble silica	9.51 } 77.49	7.26 } 77.72	8.30 } 70.92
Potash (K_2O)	.93	.90	.95
Soda (Na_2O)	.42	.33	.50
Lime (CaO)	1.75	2.26	5.07
Magnesia (MgO)	.82	1.91	.84
Br. ox. of manganese (Mn_3O_4)	.05	.04	.06
Peroxide of iron (Fe_2O_3)	7.07	7.85	6.43
Alumina (Al_2O_3)	7.72	5.72	4.88
Phosphoric acid (P_2O_5)	.20	.13	.21
Sulphuric acid (SO_3)	.03	.06	.06
Carbonic acid (CO_2)	------	------	3.76
Water and organic matter	3.49	2.82	6.02
Totals	99.97	99.74	99.70
Humus	.58	------	1.99
Ash	.26	------	1.13
Sol. phosphoric acid	.02	------	.03
Silica	.20	------	.96
Hygroscopic moisture (absorbed at 15° C.)	1.98	2.22	5.81

The showing made by these analyses places these two soils high in the scale of productiveness, with large proportions of potash, lime, and phosphoric acid; and it is a curious fact that the lowland or moist soil differs from the mesa soil in only one material point so far as the mineral ingredients are concerned, namely, the lime percentage. Supposing the two to be derived from the same original material, this accumulation of lime in the lowland soil is to be expected on general grounds. The same

is of course true as regards the humus, which, with the greater moisture and more luxuriant growth borne by the soil that is naturally moist throughout the season, must also be expected.

It is important to compare these soils with those of other parts of the southern region, which are supposed to be reasonably well represented on the station plots. A reference to the analyses given farther on, of four soils and subsoils from Riverside, and of six from the Temescal Valley, near South Riverside, shows a very near correspondence, in all important points, in the mesa materials proper.

RIVERSIDE SOILS.

The soils occurring within the limits of the Riverside basin are substantially of two chief types, the intermixture of which produces the best soils for citrus culture, and occupy the largest areas. Pure granite soils, of a very light type, occupy the slopes and immediate base of the granitic ridges of the region, and may be seen characteristically at the west end of Roubidoux Mountain and elsewhere. On the other hand, more or less heavy orange-tinted loams form a practically continuous belt, or upper terrace, along and around the whole of the San Bernardino Valley; they appear in force from Redlands southward, especially in the San Timoteo Cañon, through which the Southern Pacific Railroad passes, up to the Gorgonio Pass; and much of this loamy ingredient in the soils of Riverside is directly traceable to that cañon, from which a conspicuous red terrace extends to and around the Riverside basin. Its continuation is there known as "Arlington Heights," the name applying specially to that portion lying above the old Riverside ditch, and now covered by the Gage Canal. The soil of the Heights is a mixture of granitic sand with the red loam of the terrace formation proper. Ridges of this red soil extend down into the older portion of the colony, but the greater portion of the lands under the Riverside ditch is of a gray tint, and ranges in texture from a light loam to what is popularly designated as adobe, although rarely so heavy as to deserve that designation in the sense in which it is mostly used outside of South California. It is not at all outside of the limits of the loams that are a postulate for citrus culture. In the lowest ground—the trough of Tequisquite arroyo—there lies quite a light, sandy soil, brought down by the overflows.

Nearly everywhere these soils are of great depth; in the breaks on the Arlington tract, profiles of as much as thirty feet of sensibly uniform red loam may be seen, and it will be noted by reference to the table below that it is of almost uniform composition, chemically, to the depth of ten feet at least. The roots of the wild shrubs are found within it to depths of from six to eight feet, showing it to be as easily penetrable to roots as it is to water; its red tint alone being proof of its perfect drainage.

The sand contained in these soils is simply pulverized and partially decomposed granite, which by its further decomposition, accelerated by cultivation, will continue to evolve available plant-food for many years to come. The original natural vegetation is vigorous, and consists largely of the white and blue sages, the shrubby sunflower, cactus, "chaparral," some clumps of greasewood, and bushes of the elder, substantially the same as on the lower ground, now mostly occupied by the orange orchards of Riverside. A good portion of these are located on precisely the same red soil, whose producing quality is therefore estab-

lished by actual experience, being practically the same as that of the lands first occupied because of their lower level and easier irrigation from the original sources of water supply.

In the table below are given the analyses of five representative soils from the Riverside region, and one (No. 1537) which is quite exceptional, and confined to particular ridges.

Nos. 809 and 812 are representative samples of the soils of the older colony lands lying under the old Riverside ditch. They were taken by Mr. G. L. Waring, of Riverside. Nos. 1406 and 1408 are from a locality about two hundred feet higher, and represent the higher lands of "Arlington Heights," lying under and irrigated from the Gage Canal. No. 1536 is from the lower ground under the Gage Canal, about four miles southeast from the town of Riverside.

Nos. 809 and 812. Light and heavy subsoils from Riverside. "When dry the soil is grayish; when wet, a light chocolate color, rather hard and gritty in character; and when flooded, and not subsequently broken up, it bakes very hard. The stiffer land is rather hard to work and unfriable, but where more sand is present it can be broken up into very small particles."—G. L. Waring.*

No. 1406. Reddish-brown sandy loam soil, with much mica and some granitic debris; from the break near the head of Flume No. 11 of the Gage Canal, Arlington Heights, Riverside; taken to a depth of twelve inches. It becomes slightly plastic on kneading with water. The vegetation is cactus, Baeria, Croton, and greasewood.

No. 1408. Under-subsoil of the above; very similar to it in color and appearance, somewhat lighter, with much mica and granitic debris; taken at a depth of from nine to ten feet.

No. 1536. Brownish loam soil, from Arlington Heights, lot 1, block 37, Windsor tract, Riverside Orange Company. Contains little mica and much coarse granitic debris; it softens when wetted, and becomes fairly plastic on kneading. Taken to a depth of twelve inches.

No. 1537. Stiff reddish-brown clay soil, spotted with whitish granitic debris, mostly feldspar, quite coarse; from the Balmoral tract, Riverside Orange Company, lower end of the Gage Canal, lot 2, block 8, of the Gage survey, Riverside. It softens slowly when wetted, and on kneading becomes extremely tenacious.

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* Report College of Agriculture for 1886, page 32.

Soils of Riverside, San Bernardino County.

	Old Riverside Colony.		Near North End of Trestle 11, Gage Canal, Arlington Heights.		Riverside Orange Company.	
	No. 809. Lighter Subsoil.	No. 812. Heavier Subsoil.	No. 1406. Reddish Sandy Loam Soil.	No. 1408. Sandy Loam Under-Subsoil.	No. 1536. Windsor Tract, Mesa Loam Soil.	No. 1537. Balmoral Tract, Red Ridge Adobe Soil.
Coarse materials>0.5mm	37.60	26.60	20.00	23.00	25.00	38.00
Fine earth	62.40	73.40	80.00	77.00	75.00	62.00
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Fine Earth.						
Insoluble matter	78.36	68.34	76.41	75.44	63.67	58.94
Soluble silica	5.62 } 83.98	7.10 } 75.44	8.20 } 84.61	8.07 } 83.51	13.70 } 77.37	14.49 } 73.43
Potash (K_2O)	.79	.97	.87	.93	.73	.69
Soda (Na_2O)	.56	.31	.29	.36	.36	.34
Lime (CaO)	1.51	1.65	1.57	1.73	1.58	1.71
Magnesia (MgO)	1.24	1.68	1.33	1.58	1.85	1.78
Br. ox. of manganese (Mn_3O_4)	.28	.04	.04	.04	.03	.03
Peroxide of iron (Fe_2O_3)	3.70	3.64	4.20	5.34	10.02	6.56
Alumina (Al_2O_3)	6.68	10.19	5.30	5.08	5.06	11.77
Phosphoric acid (P_2O_5)	.11	.05	.14	.16	.07	.03
Sulphuric acid (SO_3)	.05	.04	------	------	.01	.01
Water and organic matter	1.66	2.41	1.60	1.44	2.74	3.87
Totals	100.46	99.96	99.85	100.17	99.82	100.22
Humus	.12	.19	.20	------	.20	.06
Ash	.31	.39	.64	------	.35	.18
Sol. phosphoric acid	------	------	.02	------	.04	.02
Silica	------	------	.26	------	.28	.10
Hygroscopic moisture	2.60	5.50	1.77	2.16	4.71	10.80
Absorbed at	14° C.	14° C.	15° C.	15° C.	13° C.	13° C.

It will be seen that in almost all respects these soils are much alike, having large supplies of potash and lime, of which substances the variations are within narrow limits. As regards phosphoric acid, it is a curious and unexpected fact that while the soils from the higher ground are well supplied with it, the heavier soils from the lower grounds—Nos. 812 and 1536—have a relatively low supply, which, in the case of the former, approaches deficiency. The explanation of this departure from the usual rule is found in the composition of the heavy red clay soil, No. 1537, which, while similar to the lighter soils in respect to the other ingredients of plant-food, is exceptionally poor in phosphoric acid, and has by its admixture (washing down from the granitic ridges) doubtless depressed the contents of the heavier soils in this respect. This "red adobe" seems to be formed directly from the granite of the ridges; and it is an important practical conclusion that wherever this heavy red soil prevails, fertilization with phosphates is preëminently called for. It is, however, ill adapted to citrus fruits at best.

But all—even the heavier soil from the lower ground—are quite deficient in humus, and correspondingly in nitrogen; so that the supplementing of the latter substance (*e. g.*, by dressings of Chile saltpeter) is indicated as the first step in fertilization, notably of orange orchards, which draw heavily on nitrogen when in bearing. Experience has already fully justified this induction, the good effects of nitrogenous fertilizers having been verified in numerous cases.

The low moisture-absorption of the light loam soils, Nos. 809 and 1406, speaks of the need of deep tillage and frequent irrigation for so exacting a tree as the orange. The more retentive soils, if well tilled, will not dry out so quickly.

SOILS OF THE TEMESCAL VALLEY.

From a special examination of the lands and water resources of the South Riverside Land and Water Company, the following points of general interest are given by consent of the company:

The colony sites of South Riverside and Auburndale cover the greater part of the lower valley of Temescal Creek; the latter, lying to northward of the stream, is a gently rolling mesa land, bounded on the southwest by the wash of Temescal Creek, to which there is an abrupt descent, or bluff. On the opposite side of that stream the land rises on a gentle slope to the base of the Santa Ana Mountains, from a minimum elevation of about five hundred to as much as one thousand four hundred feet, forming a plateau slope from two to three miles wide, on the upper portion of which is the townsite of South Riverside. The soil on both sides is prevalently of the reddish-loam character. On the right (Auburndale) side this loam is usually free from gravel, and sometimes quite sandy; on the South Riverside slope it is almost throughout much mixed with gravel. There is, generally, little change in the character of these soil-materials for depths ranging from five to ten feet; in wells a much greater thickness has been observed. These mesa soils become somewhat heavier as the Santa Ana foothills are approached, because of the red clayey material that forms the base of the slopes, locally passing into veritable adobe. Sometimes they are heavily packed with gravel, mostly of light-colored granite, with more or less of black siliceous schist. On the lower slope, near the South Riverside townsite,

and reaching higher up as the Santa Ana River is approached (near Rincon), there lies a gray, and usually very gravelly soil, the gravel being chiefly a dark-colored siliceous schist, derived from the upper cañons of the valley. This land is quite distinct from the reddish mesa soil, and may be considered the "wash" of the Temescal Valley at a time when the water was of much greater volume than at present.

The natural vegetation of these mesas is that of the dry mesas of South California generally—some cactus, white sage, sagebrush, and herbaceous plants of similar import; at many points the bunch grass (*Festuca*) forms a conspicuous and welcome ingredient of the vegetation. The shallow washes, or coulèes, that in time of heavy rains carry off the surplus water of the cañons, are marked by a vigorous growth of two species of sumac, the California buckthorn, some chaparral (*Ceanothus*), greasewood, and scattered elder bushes. The adjacent slopes of the Santa Ana Range are kept green all the year by a short growth of chaparral, toyon (*Heteromeles*), buckthorn, and scrub oaks, in pleasant contrast to the bare, rocky sides of the Sierra Madre and Temescal Ranges opposite.

The following table shows the result of the analysis of a number of soils taken at various points so as to cover essentially the two colony tracts. All except Nos. 1249 and 1245 represent the soil layer from the surface to the depth of twelve inches.

No. 1248. *Soil* from the foot of the slope (lot 7, block 67), South Riverside, typical of the valley "wash" referred to above. Gray, very gravelly; natural vegetation originally cactus patches, with turkey-weed, sunflower, tar-weed, and elder bushes. Quite plastic when kneaded, does not darken much in wetting; gravel all well rounded; much black siliceous schist.

No. 1246. *Mesa soil* from an orange orchard on lot 6, block 43, nearly on the division line between the gray soil of the lower lands and the reddish mesa soil; dark colored, with but little gravel; a rich-looking blackish loam, becoming quite plastic on wetting, and darkening considerably in color. Original vegetation, turkey-weed, tar-weed, sunflower, and elder bushes.

No. 1251. *Mesa soil*, twelve inches deep, from tract on the line of the pipe-line, lot 2, block 31, representing about the middle of the mesa slope, near the eastern line of the company's lands. A reddish, gravelly loam, darkening considerably on wetting, and becoming quite plastic. Original vegetation about the same as the preceding number. The gravel is largely angular, and mostly granitic.

No. 1253. *High mesa soil*, twelve inches deep, from the high mesa (one thousand three hundred feet), half a mile from the foothill slope, lot 6, block 3, near the line of the Garretson tract; represents fairly the mesa within a mile or a mile and a half of the foothills of the Santa Ana Range. Quite reddish, with much angular gravel, mainly granitic; becomes very plastic on wetting, and darkens materially in color. Vegetation: bunch grass, alfilerilla, turkey-weed, and tar-weed.

No. 1249. *Subsoil* from the bottom of the ditch, six feet below the surface, at the crossing of Ontario and Buena Vista Avenues. Very gravelly, reddish-gray loam, less clayey than the surface at the same point.

Nos. 1244 and 1245. *Soil and subsoil* from the Auburndale tract, lot 1, block 90. A fair average of the tract at large; the subsoil, at a depth

of twelve to thirty inches, being chosen for examination on account of the great depth of the unchanged soil stratum, which in breaks is shown to be uniform for six to eight feet. Natural vegetation: patches of cactus, much bunch grass, turkey-weed, alfilerilla. The soil contains much coarse white sand, and becomes only slightly plastic on wetting, while darkening but little in color.

Analyses of Soils from the South Riverside and Auburndale Colony Lands.

	No. 1248. "Temescal Wash," Block 67, Lot 7. Soil.	No. 1251. Block 31, Lot 2, East-end, near Pipe-line. Mesa Soil.	No. 1246. Block 43, Lot 6, near Townsite. Mesa Soil.	No. 1253. Block 3, Lot 6, near Garretson's. High Mesa Soil.	No. 1249. Pipe-line Ditch, Ontario Ave. Mesa Subsoil.	No. 1245. Block 90, Lot 1, Auburndale. Mesa Subsoil.	No. 1244. Block 90, Lot 1, Auburndale. Mesa Soil.
Coarse materials >0.5mm	20.00	17.00	27.50	57.00	80.00	30.00	----
Fine earth	80.00	83.00	72.50	43.00	20.00	70.00	----
Analysis of Fine Earth.							
Insoluble matter	67.38	71.89	58.19	69.86	73.57	73.44	----
Soluble silica	10.69 } 78.07	8.43 } 80.32	14.53 } 72.72	8.69 } 78.55	6.44 } 80.01	10.06 } 83.50	----
Potash (K_2O)	.74	1.17	.68	1.17	1.35	.77	----
Soda (Na_2O)	.11	.13	.24	.33	.25	.19	----
Lime (CaO)	1.11	1.19	1.15	.96	.57	1.10	----
Magnesia (MgO)	1.40	1.29	1.30	1.27	.87	1.01	----
Br. ox. of manganese (Mn_3O_4)	.14	.04	.05	.04	.05	.04	----
Peroxide of iron (Fe_2O_3)	7.79	5.39	9.29	5.79	4.93	5.17	----
Alumina (Al_2O_3)	6.32	7.04	8.29	8.15	8.72	5.84	----
Phosphoric acid (P_2O_5)	.09	.11	.12	.11	.07	.10	----
Sulphuric acid (SO_3)	.02	.01	.07	.04	.04	.02	----
Water and organic matter	3.79	3.47	6.09	3.90	2.91	2.39	----
Totals	99.58	100.15	99.96	100.31	99.77	100.13	----
Humus	.69	.64	1.09	.84	----	----	.49
Ash	.73	.54	.59	.77	----	----	.53
Sol. phosphoric acid	.03	.04	.04	.04	----	----	.03
Silica	.61	.35	.37	.29	----	----	.34
Hygroscopic moisture (absorbed at 15° C.)	7.84	3.00	6.89	3.10	4.43	4.50	----

The salient point in the composition of all these soils is their high content of *potash*, exceeding 1 per cent in three cases in the South Riverside tract. This, with the large proportion of the same substance contained in the irrigation water, noticed elsewhere, guarantees the cultivator against the need of supplying this ingredient for a long time.

Lime, also, is in ample supply in all the soils, including the "wash" soil of the lower land. A somewhat unusual feature is, that the subsoil at six feet (No. 1249) contains only half as much as the surface soils, owing probably to its more sandy nature.

Phosphoric acid, likewise, is in good supply in all, and will not require artificial supplementing for a number of years, since an unusually large proportion is in the soluble condition.

The supply of *humus*, or vegetable matter (and with it that important substance, nitrogen), is unexpectedly large for mesa soils, especially in No. 1246, which contains about three times as much as is commonly found in such soils. In the rest it is at least adequate.

As regards *physical properties*, it will be noted that Nos. 1253 and 1249 are quite gravelly; none are close; all are easily tilled. Nos. 1248 and 1246 possess a much higher power of absorbing moisture than the rest, and will, therefore, be less sensitive to heat and drought. The rest are in this respect more nearly like the generality of mesa soils in Southern California.

As a general result, it may be said that these soils are of very high quality, and, in view of their physical character, depth, and good drainage, may be considered as especially well adapted to the culture of citrus, as well as most deciduous fruits, and also to the olive; considering the climate, the almond seems to be particularly indicated as a promising crop.

Soil-Forming Materials from Near Santa Monica.—The materials, of which the analyses are given below, were analyzed at the request and expense of the Forestry station, near Santa Monica. It is stated that they constitute the two chief varieties of material from which the hillside soils of that region are formed; hence, it was desired to know their probable permanent value as supporters of forest growth.*

No. 1521. Gray silty clay, from hillside near Forestry station, Santa Monica, Los Angeles County; sent by Mr. William S. Lyon, State Board of Forestry, Los Angeles. This is an indurated soil-forming material; only slightly plastic with water; the lumps are rather easily crushed between the fingers.

No. 1522. Yellow ochreous earth, from hillside near Forestry station; sent by Mr. William S. Lyon. This material is quite indurated, but crushes rather easily between the fingers, and becomes quite plastic with water. Its iron is in the form of fine grains of limonite or yellow ochre.

*See Bulletin No. 6 of the California State Board of Forestry, page 5.

Analyses of Soil-Forming Materials, Santa Monica, Los Angeles County.

	No. 1521. Gray Silty Clay.		No. 1522. Yellow Ochreous Earth.	
Insoluble matter	49.95	70.68	48.57	56.82
Soluble silica	20.73		8.25	
Potash (K_2O)	1.09		1.54	
Soda (Na_2O)	.66		.85	
Lime (CaO)	3.23		8.14	
Magnesia (MgO)	2.86		2.45	
Br. ox. of manganese (Mn_3O_4)	.05		.02	
Peroxide of iron (Fe_2O_3)	8.11		18.19	
Alumina (Al_2O_3)	6.77		1.51	
Phosphoric acid (P_2O_5)	.23		.28	
Sulphuric acid (SO_3)	2.65		.73	
Carbonic acid (CO_2)	------		3.18	
Water	3.60		6.38	
Totals	99.93		100.09	
Hygroscopic moisture (absorbed at 15° C.)	10.87		------	

The gray clay, on leaching, yielded 4.40 per cent of soluble salts, mostly gypsum.
The yellowish earth yielded, on leaching, 3.18 per cent of soluble salts, which consisted chiefly of common salt, very little gypsum, and some sulphates of soda and potash.

Both of these materials are rich in the essential mineral ingredients of plant-food; No. 1522 particularly so, since it contains over one and a half per cent of potash, and nearly three tenths of one per cent of phosphoric acid; the latter an extraordinarily high amount for this State. Both are strongly calcareous, the yellow variety especially so, and both have a very high power of absorbing moisture. Both contain some "alkali," but of the mild ("white") form, as must be the case in the presence of a considerable proportion of *gypsum* in both. Apart from the alkali, which may have been present accidentally in samples taken from the surface, in larger proportion than would be the case in soils formed from these materials, such soils would be exceedingly productive, if adequately supplied with vegetable matter, or, in its absence, with nitrogenous fertilizers.

It will be interesting to ascertain what is the extent of the area of occurrence of soils so unusually rich in phosphates, and to determine whether or not the latter exist in a more concentrated form, available for use as fertilizers; such deposits having lately been actually discovered in the neighborhood of South Riverside.

No. 1238. Bottom soil of Sweetwater Valley, San Diego County; sent by Mr. Wallace D. Dickinson, of San Diego, for the purpose of ascertaining if the land is suitable for potatoes. He says:

Two or three Italians in the Otay Valley have each year planted potatoes in August, irrigating the same with windmills. Last season I determined to experiment with some valley land of my own, lying in the valley of the Sweetwater, and irrigable from the Sweetwater Reservoir. So in June I plowed the land (then very dry), and, making ditches through it, thoroughly soaked the soil; then I ran a cultivator through it, and furrowed it out accurately two and one half feet apart; dropped the seed (good looking and very mature from the fall crop) four inches deep, and covered it by running a "Junior" cultivator between the rows, with the plow wings properly set; this worked quickly and nicely. Two and a half acres were thus planted. I was badly disappointed to find that but few hills came up, and I spent a half day among the Italians trying to locate the trouble. They agreed that the seed was too old, and that potatoes should be planted whole when irrigated. So I replanted the plot with very good, small seed potatoes, some of which were beginning to sprout. The immature seed failed to show any sprouts; from the rest I gathered a crop about November first, realizing about eighty-five sacks per acre.

In the meantime, however, I had planted another plot on September twentieth, which met with a fate that I would like to have explained. In October, when the plants were about eight inches high, a frost killed about 5 per cent of them, while the balance recovered and were very promising, with a strong, healthy growth, and just beginning to blossom. As I expected rain, I postponed irrigating them until they were pretty dry, though a Chinese gardener claimed they were plenty wet—"heap water no good for potatoes." But as they had not had water for four weeks, I commenced to irrigate, but was interrupted by a heavy rain. Within one week at least one third of the tops were dead, and in two weeks not a green top remained; the potatoes were the size of walnuts, and rotted in the ground at once. Why? Is the soil (a sample of which is sent) suitable for potatoes, or does it require fertilization? I irrigated the plants by allowing the water to flow along center ditches between the rows.

The examination resulted as follows:

Bottom Land of Sweetwater Valley, San Diego County.

	No. 1238. Soil.
Insoluble matter Iron, alumina, etc.	95.45
Potash (K_2O)	.64
Soda (Na_2O)	.22
Lime (CaO)	1.06
Phosphoric acid (P_2O_5)	.06
Water and organic matter	2.57
Total	100.00

For a sandy soil the plant-food percentages are quite large, and even as to humus, which is a common deficiency in the soils of the southern region, the sample is well supplied. The difficulties met with in the above cultivation of the potato are probably purely climatic, or due to the constant high temperature during the late growing season proposed for the crop.

While it is true that the potato is a native of Arizona and northern Mexico, yet in its native habitat it occupies mountain locations, and its tubers are very small. It has been called the "Irish potato" from its peculiar adaptation to a climate about as different from that of Sweetwater Valley as can well be, and it is credited with producing there the maximum of tubers of the best quality.

When the cut potatoes were planted in a hot soil (in July), where they got warm and began to dry on the outside before the water was put on, then chilled down with that water after they had gotten pretty well set with "microbes" in a highly "septic" soil, it was quite natural that the microbes and not the potato germs grew.

Experienced irrigators are agreed that all violent changes caused by the application of water to the roots are dangerous; hence, when it becomes necessary to irrigate during the hot weather the water is not run very close to trees, nor very abundantly at a time, and thus the change is made more gradual.

No. 1092. Soil from Palm Valley, San Diego County; sent by Mr. S. W. Fergusson, San Francisco. This is a grayish, light, loose soil, with small particles of mica, both gray and golden, and of quartz. The Palm Valley Colony is situated on the eastern slope of the San Jacinto Range, off Seven Palms Station, on the Southern Pacific Railroad.

Soil of Palm Valley, San Diego County.

	No. 1092. Light Gray Soil.	
Coarse materials >0.5mm	None.	
Fine earth	All.	
Analysis of Fine Earth.		
Insoluble matter	71.45	76.95
Soluble silica	5.50	
Potash (K_2O)	1.42	
Soda (Na_2O)	.18	
Lime (CaO)	2.20	
Magnesia (MgO)	2.09	
Br. ox. of manganese (Mn_3O_4)	.05	
Peroxide of iron (Fe_2O_3)	6.08	
Alumina (Al_2O_3)	5.78	
Phosphoric acid (P_2O_5)	.35	
Sulphuric acid (SO_3)	.01	
Carbonic acid (CO_2)	.18	
Water and organic matter	4.29	
Total	100.18	
Humus	1.07	
Ash	.23	
Sol. phosphoric acid	.03	
Hygroscopic moisture (absorbed at 13° C.)	2.06	

There is also .16 per cent "soluble alkali" in this soil, which consists of sulphate of soda (Glauber's salt), sulphate of potash, and a little common salt, not enough to be hurtful.

The analysis of the sample indicates a very rich soil, in which the percentages of plant-food (potash and phosphoric acid) are *very high;* lime and humus in good proportions. Should other conditions, as depth, drainage, and climate, be also favorable, this should be an extremely fertile and thrifty land. In texture it is a light loam, easily tilled.

Soils from the Bottom Lands of the Colorado and Gila Rivers.—An analysis of a sample of soil from the Colorado bottom land, near Yuma, was given in a former report (see page 39, report for 1882). This analysis is reproduced below for comparison with those of a soil and under-subsoil from the Gila River bottom, near the junction of that stream with the Colorado. These samples were sent, with request for analysis, by Mr. Hiram Blaisdell, of Yuma, and the result is here given by his permission.

The three samples are very much alike—of a pale fawn color when dry; fine-textured, silty, with no coarse sand or gravel of any kind. The subsoil, No. 1197, is hardly to be distinguished from the surface soil. They lie loosely, and can be compressed considerably with little exertion. Their natural vegetation is mainly mesquite and "Colorado Hemp."

Colorado and Gila Bottom Soils.

	No. 506. Colorado River, California. Bottom Soil.		No. 1195. Gila River, Arizona. Bottom Soil.		No. 1197. Gila River, Arizona. Bottom Subsoil.	
Insoluble matter	58.57	63.90	57.90	71.39	64.83	76.68
Soluble silica	5.33		13.49		11.85	
Potash (K_2O)	1.18		.66		.67	
Soda (Na_2O)	.16		.25		.39	
Lime (CaO)	8.67		6.26		4.33	
Magnesia (MgO)	2.97		.66		1.97	
Br. ox. of manganese (Mn_3O_4)	.03		.08		.03	
Peroxide of iron (Fe_2O_3)	4.14		5.57		6.27	
Alumina (Al_2O_3)	8.38		7.48		4.27	
Phosphoric acid (P_2O_5)	.13		.23		.17	
Sulphuric acid (SO_3)	.15		.03		.05	
Carbonic acid (CO_2)	7.82		2.63		3.56	
Water and organic matter	3.34		4.98		1.44	
Totals	100.87		100.22		99.83	
Humus	.75		.38			
Ash	1.15		.43			
Sol. phosphoric acid			.02			
Hygroscopic moisture (absorbed at 15° C.)	9.26		4.91		3.48	

It will be noted, as a common feature of these three soils, that they are highly calcareous; they show the presence of carbonate of lime by effervescence with acids. The Colorado soil is very rich in potash; the Gila soil much less so, yet very adequately supplied; the amount of soda found does not indicate much alkali contamination. The Colorado soil has a good but not high supply of phosphoric acid; the Gila soils both show an unusually high percentage of that ingredient. The Colorado soil has a good supply of humus; the Gila soil is notably deficient therein for a bottom soil. The latter point is explained by the fact, collaterally ascertained, that at low stages of water the Gila River carries enough alkali (carbonate of soda) to exert a sensible solvent action upon the humus of the soil.

Although none of these materials become properly plastic on wetting and kneading, it will be noted that the Colorado soil shows a very high moisture-absorption, and a high percentage of alumina. In what form the latter is present, and what determines the high moisture-coefficient in this case, remains to be determined. In the Gila soil the moisture-absorption is, at least, fair.

Taken altogether, these soils should be highly and lastingly productive, and easily tilled if exempt or protected from overflow, and should be adapted to a great variety of crops, determined more by the moisture conditions than by any other factor.

II. ANALYSES OF WATERS.

A. STREAM AND LAKE WATERS.

Water from the streams of Pleasant Valley; sent by Mrs. M. E. Cleary, Coalinga, Fresno County. This water has a laxative effect upon persons drinking it for the first time, though after becoming accustomed to its use it seems to lose that effect, except in warm weather. Fruit trees and vines, and all kinds of grain and most vegetables thrive when irrigated with the water, but small shrubs and flowers sicken and die from the effects.

An examination of the water shows it to hold in solution 119.4 grains of mineral salts per gallon, consisting chiefly of sulphate of soda, or Glauber's salt, which renders it entirely unfit for domestic use, that salt being a purgative much used in veterinary practice. Its continued use by persons will induce weakness of the digestive organs, and end in chills and fever, or some kind of constitutional derangement. If used for irrigation purposes, it will also injure the plants unless applied in such a manner and in such abundance as to prevent entirely the accumulation of salts near the surface by evaporation, which practically is hardly feasible. The nature of the water fully explains the fact stated above, that while trees grow well, smaller plants (with shallower roots) are not successful. The latter have their roots entirely immersed in the soil saturated with Glauber's salt, from which they suffer; while the deep-rooted plants have the greater portion of *their* roots below the point of damage, and can thus survive and even flourish, since the neutral salt does not corrode the bark or root-crown.

Water of Tulare Lake, from near the middle (north and south), three miles from shore; stated to have been taken ten feet below the surface of the lake by a messenger sent by Mr. B. F. Moore, Tulare. The sample is slightly turbid, and has a fishy after-taste.

Water of Tulare Lake, said to have been taken on the northeast side, two miles from shore, and one half mile beyond vegetable growth, two feet below the surface of the lake, or four and one half feet above the bottom, by Mr. T. A. Coonradt, Tulare. The sample was slightly turbid.

Water of Tulare Lake.

	Middle of Lake.		Northeast Side of Lake.	
	Grains per Gallon.	Parts in 10,000.	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	60.16	10.30	29.77	5.10
Soluble in water after evaporation	43.46	7.44	18.82	3.22
Insoluble in water after evaporation	9.11	1.56	5.81	1.00
Organic matter and chemically combined water	7.59	1.30	5.14	.88
The soluble part consists of—				
Sodium and potassium sulphates (Glauber's salt, etc.)	19.88	3.41	4.86	.83
Sodium chloride (common salt)	3.77	.64	4.98	.85
Sodium carbonate (sal soda)	19.81	3.39	8.98	1.54
The insoluble part consists of—				
Calcium and magnesium carbonates / Calcium sulphate (gypsum)	7.71	1.32	4.12	.71
Silica	1.40	.24	1.69	2.29

The above analyses are difficult to reconcile, particularly as to total of salts present, with those made in former years upon well authenticated samples, and probably represent only local accumulations of mixtures of fresh water with the strong water of the lake, as analyzed in 1880 and 1888. There certainly has been no such extensive change in the area of the lake as would seem to be indicated here.

Water of Lake Elsinore, San Diego County; sent by Mr. Peter Wall, Elsinore, January, 1891. The water is clear, but has a faintly brackish taste.

Water of Lake Elsinore; sent by Mr. N. Messer, Wildomar, San Diego County, January, 1890. The sample is clear and colorless.

Water of Lake Elsinore.

	1890.		1891.	
	Grains per Gallon.	Parts in 10,000.	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	103.21	17.67	84.34	14.44
Soluble in water after evaporation	95.21	16.30	71.84	12.30
Insoluble in water after evaporation	2.75	.47	5.96	1.02
Organic matter and chemically combined water	5.25	.90	6.54	1.12
The soluble part consists of—				
Sodium and potassium sulphates (Glauber's salt, etc.)	76.00	13.00	14.85	2.55
Sodium chloride (common salt)			43.37	7.42
Sodium carbonate (sal soda)	19.21	3.30	13.62	2.33
The insoluble part consists of—				
Calcium and magnesium carbonate / Calcium sulphate (gypsum)	2.75	.47	5.49	.08
Silica	Trace.		.47	.94

There is quite a difference in the amount of mineral contents of the two samples, that taken recently having the least amount, especially of the alkali salts. This difference, or rather diminution of the mineral matter, is due entirely to its dilution, caused by the influx of pure water from the San Jacinto River last winter, and which made the lake overflow into Temescal Valley, and seemed to make "soap" with the water of Lee's Lake, so that the creek frothed all over the riffles.

Even with this dilution the water of Elsinore Lake is too strong in alkali salts to be used for *continued* irrigation purposes. It would do for a few years, and then the land would be "dead" with alkali—"black alkali" at that.

THE WATER SUPPLY OF THE TEMESCAL VALLEY.*

The South Riverside Land and Water Company's supply is derived from the watershed of Temescal Creek—a total of about one hundred and seventy-five square miles—mainly on the Santa Ana Range, from which deep and long cañons descend into the valley, while from the opposite steep and rocky slopes of the Temescal Range (the foot of which is closely hugged by the creek in its upper course) only a few and comparatively insignificant runlets find their way into the valley. Again, the cañons lying immediately adjacent to the colony lands of South Riverside furnish but a relatively small, though by no means insignificant, water supply, which requires storage reservoirs for the winter waters. One such has already been established at the mouth of Hagador Cañon, and excellent natural sites for large reservoirs exist near the mouth of Lord's Cañon. The cause of the relatively scanty permanent flow from these gorges is manifestly the nature of the geological formation of the hills, which, near their base, is a structureless red loam, that has materially contributed to the soils below; and farther back, the sandy clays of the older (Tertiary) beds, in which, likewise, water-shedding strata are very rare, and springs therefore scarce. Very much the same state of things prevails in several other cañons above, such as Manning's, Damron's, White's, and Anderson's; they do not reach back far enough into the rocky, central mass of the range.

Ascending the valley, Coldwater Cañon is the first that yields an important permanent flow, and still above, Mayhew, Peter Wall, and Horsethief Cañons carry streams that flow throughout the year. The width of the Temescal Valley, in this upper portion, is from one to one and a half miles between the mountain slopes; but within it there lie bodies of low hill or mesa land, dividing it lengthwise into two portions. Through the narrow one, at the foot of the eastern or Temescal Range, flows the main creek; while more or less definite "washes" mark the points where, in times of flood, the waters of the cañons find their way across the valley from the Santa Ana Mountains. These washes are formed of great masses of debris, whose material is mostly granitic sand, gravel, and often huge bowlders of the same material, as well as of black-and-white-banded siliceous schist; showing both their origin in the central rock-masses, and proving the copious rainfall of the higher portions of the Santa Ana Range. A continuous flow of water in these washes exists but rarely, and for a short time; the porous nature of the deposits readily explains the disappearance of the waters from view.

What becomes of the latter, is a question intimately connected with the valley's supply of irrigation water. A glance at a general map would seem to indicate that the Temescal Creek is but the natural continuation of the San Jacinto River, which empties into Elsinore Lake; and from the latter a conspicuous channel leads directly into the

* Abstract from a report made to the company, July, 1890.

Temescal Valley. In other words, Temescal Creek is the natural outlet of Elsinore Lake; but actual *flow* from the lake occurs only at long intervals. It has existed in 1890 for four months, finally ceasing on or about July twenty-fifth; the last previous occurrence of such connection was in 1884; the last before that in 1864. It might be supposed that underground connection, through gravel beds, might, nevertheless, take place all the time. A close examination made of the channel between the head of Temescal Valley and the outlet of Elsinore Lake, has shown that this is not the case, since impervious clay deposits intervene at several points, where the water would have to come to the surface. Moreover, the continuous concentration of the water of Elsinore Lake by evaporation, as shown by evidence, and analysis given above, shows clearly that under ordinary conditions of rainfall Elsinore Lake has no outflow of any importance. When it occurred in 1890 the water of Temescal Creek for some time was strongly tainted, as with soap, from the admixture of the alkaline water of the lake. Upon the cessation of the surface flow from the lake the water resumed its usual character of a mountain stream. But, to the casual observer, it now appears to be (to borrow a legal phrase) "without visible means of support."

About eleven miles (on a direct line) above the townsite of South Riverside there is a long, shallow lake basin, about eighty acres in extent, called (from the first settler near by) Lee's Lake. From the lower end of this (partly tule-covered) sheet of water issues the ordinary flow of Temescal Creek, while little or no flow enters the upper end of the lake. Examination shows that the latter is fed by numerous springs (amounting in places to a continuous copious ooze for many yards) coming in from the southwest or Santa Ana side of the valley, and most abundant in front of the "washes" of Horsethief and Peter Wall Cañons. It is obviously the flow of these gorges, absorbed within the great masses of debris they have deposited between their exits from the Santa Ana Range and the course of the main creek at the foot of the opposite slope, that with slow movement feeds the lake and the flow of the creek at its outlet, which in the dry season amounts to about four hundred miner's inches.

Cienegas.—While there can be no doubt that the waters of Horsethief and Peter Wall Cañons reach Lee's Lake more or less directly through the gravel and sand beds formed by them, and are substantially continuous across the valley, the same is not true of the two cañons below, viz.: Mayhew's and Coldwater. The former, nearly two miles below Peter Wall's, is separated from it by hilly or mesa land, previously referred to, which is mainly composed of clayey strata, partly of an old formation (Miocene), practically impervious to water. The Mayhew wash crosses these hills through a narrow pass; but wells, sunk close by, show that the gravel wash is only superficial, and that a clay mass or dam cuts off any considerable underground flow from the cañon to the creek. The same condition of things prevails where the Coldwater wash occasionally pours its flood waters into Temescal Creek.

The natural result is that the debris of these two cañons have been piled up back of the clay ridges into heavy gravel beds, into which the waters are absorbed and stored, forming an extensive tract of moist or cienega land, from which water naturally bursts forth at many points in the form of copious springs, and from which, as experiment has shown, a still further supply can be drawn by artesian borings, or, as

has actually been done, by tunneling into the cienega from a lower level. In the experimental tunnel so driven (at Riley's Cienega), a flow of twenty-five to thirty inches rushed in through a small hole, so soon as the last of the clay wall was broken through, forty feet below the surface.

The areas which may be properly designated as cienega land, showing the peculiar black soil that characterizes such spots, may be enumerated as follows:

1. The *"Compton" Cienega*, embracing about twenty acres of absolutely wet (tule) land, or one hundred and sixty acres of moist, all told, lies midway between Mayhew and Coldwater Cañons, where they approach nearest (one half mile), and but a short distance from the foot of the "clay hill" belt of the valley. From this wet land there has always been a steady surface-flow of between fifty to sixty inches. Three artesian wells have been bored within this cienega, one to the depth of three hundred, the two others to that of about one hundred and fifty feet, all in granitic gravel. There appeared to be no material increase of flow with greater depth, the discharge being steadily about twenty-five inches each from wells Nos. 1 and 2, and over twenty inches from No. 3. The water of the latter at present discharges from a pipe laid to a school house near by, twenty-five feet above the mouth of the well; the three aggregate seventy-two inches.

2. The *"Rolfe" Cienega*, distant from the preceding about one fourth of a mile southeasterly, just beyond the wash of Coldwater Cañon, has three hundred and fourteen acres of wet land, part of which is so full of springs, and with the luxuriant vegetation so dangerous for roaming cattle, that it has been fenced for safety. Four ten-inch artesian wells have been bored here to depths ranging from one hundred and twenty-five to one hundred and forty-five feet, all the time in granitic gravel. The flow of the borings here is more copious than in the Compton Cienega. Besides this, there is a considerable surface-flow, which has not been sensibly diminished by the boring of the wells, reported as amounting to as much as three hundred inches before boring the wells; this makes the total discharge from the Rolfe and Compton Cienegas about six hundred inches.

The two cienegas are connected by a pipe-line, and their joint overflows from wells and surface are gathered into a reservoir, and pass on to the Riley Cienega.

3. *Riley's Cienega* is distant about three fourths of a mile due north from the artesian wells in the Rolfe Cienega, and about seven acres in area. This small cienega, like the last, lies on the course of Coldwater Cañon wash, which here passes right at the base of the clay hills on the east side, while the same close in, within a few hundred yards, on the west also. Here (as previously mentioned) a tunnel was driven from the main pipe-line toward the cienega, with the intention of tapping it at some depth below the surface, the result being that, as stated above, a twenty-five-inch stream of water burst in through a hole about eight inches in diameter, when the clay wall was broken through into the gravel of the cienega. Nothing has since been done to increase this flow, which has risen to thirty inches at the last measurement made (July 2, 1888).

4. The *Harrington Cienega* lies two and one half miles below the Riley tract, on the course of the main Temescal Creek, which is almost lost at the upper end of the moist land, but reappears at its lower end, being

forced to the surface by granite ledges which here confine the valley to a short gorge; at its narrowest point the latter is only three hundred feet across. The full flow of the creek passes over the granite rocks as a waterfall, of considerable volume when seen by the writer in June of the present year. The moist land above, much of which is overgrown with willows and cottonwood, is about seven acres in area. There can be no question that it is fed essentially by the main creek, which was compelled to drop its gravel in consequence of the barrier across its course. Its altitude at the lower end is eight hundred and forty-two feet.

Below the Harrington gorge, Temescal Creek gradually becomes smaller in volume as it sinks into the gravel beds, and in years of ordinary rainfall is not seen to carry any water below the bridge on the Riverside road (Magnolia Avenue). In June, 1890, however, it not only flowed past the townsite itself, but reached the Santa Ana River as a definite stream, flowing mostly along the foot of the Auburndale bluffs.

Character of the Waters—Chemical Composition.—The water of the artesian wells is limpid and cool, and very pleasant for drinking; that of Lee's Lake is, of course, more or less charged with vegetable matter derived from the tule and other growth that luxuriate in portions of the water-covered area. The subjoined analyses of samples representing the two kinds of water contributing to the South Riverside system, one taken from the largest well in the Rolfe Cienega, the other from the western margin of Lee's Lake, show their character:

Composition of South Riverside Irrigation Waters.

	Artesian—June 24, 1890.		Lee's Lake—August 31, 1890.	
	Grains per Gallon.	Parts per 10,000.	Grains per Gallon.	Parts per 10,000.
Total solid contents	13.20	2.260	14.14	2.425
Strictly mineral matter	12.00	2.054	12.25	2.147
Soluble after evaporation	*3.96*	*.679*	*2.77*	*.475*
Sodium chloride (common salt)	.55	.094	1.00	.170
Sodium sulphate (Glauber's salt)	2.11	.361	.71	.123
Sodium carbonate	.55	.093	.50	.085
Potassium sulphate	.75	.131	.56	.096
Insoluble after evaporation	*8.03*	*1.375*	*9.68*	*1.672*
Calcium sulphate (gypsum)	.88	.151	.13	.022
Calcium carbonate	4.49	.770	5.76	1.000
Magnesium carbonate	.80	.137	.82	.141
Peroxide of iron	.06	.012	.11	.020
Silica	1.80	.305	2.86	.490
Organic matter (small) and water	1.20	.205	1.68	.290

The total mineral contents of these two waters would, when mixed in equal proportions, average about twelve and one fourth grains per gallon. This, taken as a whole, is over five grains less than is contained in the water of the Los Angeles River, and less by three and one fourth grains than that in Warm Creek (the old Riverside ditch); it is almost precisely the average of the Gage artesian wells at Riverside. Inspection shows that of the total of mineral matter, only one third in the artesian water, and less than one fourth in the lake water, consists of soluble or "alkali" salts, the rest being earthy matter that always forms an accept-

able contribution to the soil-mass. But of the permanently soluble portion a considerable part—three fourths of a grain in the artesian water—consists of a highly valuable fertilizing substance, viz.: potassium sulphate, the potash being manifestly derived from the granitic rocks and debris from which all these waters flow. While three fourths of a grain per gallon may seem a small amount, it ceases to be insignificant when multiplied by the number of gallons expected to be used on an acre of ground in the course of a year. Allowing only one inch (four-inch pressure) to ten acres, we obtain for the weight of the potash thus brought on the land twenty-seven pounds, worth, in the form of the sulphate, $1 25 wholesale, at New York. While this may not seem a very important offset to the cost of irrigation water, the fact is that there is, even thus, supplied the full amount of potash required for a heavy crop of wheat (thirty bushels), including straw, or two and one half such crops of grain, exclusive of straw, or for a five-ton crop of grapes, which draw more heavily on potash than does any other fruit. It is clear that with what is always in addition supplied by the soil, the heaviest crops expected to be grown on these lands will not render fertilization with potash necessary, so long as these waters are used in irrigating it.

Water from the Gila River, taken at different seasons and sent by Mr. Hiram W. Blaisdell, Yuma, Arizona. These samples were analyzed for the sender in order to determine whether well or river water would be best for use at different times of the year.

	Grains per Gallon.			Parts in 10,000.		
	Sample taken June 5.	Sample taken June 23.	Sample taken July 8.	Sample taken June 5.	Sample taken June 23	Sample taken July 8.
Total residue by evaporation	70.10	90.30	112.20	12.00	15.46	19.20
Soluble in water after evaporation	46.70	61.50	76.60	7.99	10.54	13.10
Insoluble in water after evaporation	17.90	22.60	22.30	3.08	3.96	3.82
Organic matter and chemically combined water	5.50	6.20	13.30	.93	1.06	2.38
The soluble part consists of—						
Sodium and potassium sulphates (Glauber's salt, etc.) Sodium chloride (common salt)	46.30	61.00	76.19	7.93	10.45	13.01
Sodium carbonate (sal soda)	.37	.50	.50	.06	.09	.09

The *insoluble part* of these waters consists of gypsum (predominating in the samples taken June twenty-third and July eighth), carbonates of lime and magnesia, and silica, with traces of iron, alumina, and phosphoric acid. This river water becomes so strong in salts during the summer as to place it beyond the pale of desirable irrigation waters. If used, the presence of carbonate of soda should be counteracted by the use of plaster (gypsum). The soil of the valley, however, is so porous that a leaching out of accumulated salts would seem to be easily effected by thorough flooding in winter.

B. SPRING WATERS.

Water from a spring, twenty-four miles from Ukiah; sent by Mr. J. M. Robinson, Ukiah, Mendocino County. The sample is clear and colorless, and contains free carbonic acid. Its composition is:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	83.29	14.26
Soluble in water after evaporation	46.14	7.90
Insoluble in water after evaporation	37.15	6.36
Organic matter and chemically combined water	Trace.	
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	1.06	.19
Sodium chloride (common salt)	1.90	.32
Sodium carbonate (sal soda)	43.18	7.39
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	35.75	6.12
Silica	1.40	0.24

The mineral contents of this water consist almost exclusively of the carbonates of soda and of lime, the latter being kept in solution in presence of the free carbonic acid gas. By boiling, the water would be freed from the gas and the lime precipitated, thus leaving a water strongly alkaline with soda. Such a water would, however, not be palatable. The water is so highly charged with soda as to render it unfit for domestic use, but as an alkaline mineral water it is of fair strength, and if sufficiently charged with carbonic acid would, doubtless, form a palatable water of good medicinal qualities.

Water from "Mt. Ida Spring," near Oroville, Butte County; sent by Mr. Adolf Ekman. "Carbonic acid and sulphuretted hydrogen gases constantly bubble up from the bottom of the spring; and cattle will swim the creeks in order to get a drink of the water, evidently appreciating its properties." The sample is clear, colorless, and tasteless. It contains a small amount of free carbonic acid gas, but no sulphuretted hydrogen was perceptible. Its composition was found to be:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	74.30	12.72
Soluble in water after evaporation	56.08	9.60
Insoluble in water after evaporation	12.38	2.12
Organic matter and chemically combined water	5.84	1.00
The soluble part consists of—		
Sodium sulphate (Glauber's salt)	31.11	5.32
Sodium chloride (common salt)	21.26	3.64
Sodium carbonate (sal soda)	3.71	.64
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	9.93	1.70
Silica	2.45	.42

The mineral content of this water is large, and the large amounts of Glauber's salt and common salt make it unfit for domestic use. It is a mild saline purgative mineral water, and its *constant* use is to be avoided, both by man and cattle; the latter are doubtless attracted by its saline nature.

Water from a mountain spring near Cloverdale, Sonoma County; sent by Mr. G. Hunziker, of Cloverdale. The sample is clear and contains a small amount of free carbonic acid. Its composition is as follows:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	6.08	1.04
Soluble in water after evaporation	2.00	.34
Insoluble in water after evaporation	3.44	.59
Organic matter and chemically combined water	.64	.11
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	.22	.04
Sodium chloride (common salt)	.54	.09
Sodium carbonate (sal soda)	1.24	.21
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	2.62	.45
Silica	.82	.14

This is an exceptionally pure water, containing a very small amount of mineral matter, being less than half of what is commonly found in the waters of that region. Among the mineral ingredients there is a comparatively large amount of carbonate of soda.

Mineral water from near Martinez, Contra Costa County; sent by Mr. Wm. J. Young. The spring from which the water was taken is situated in the bottom of a deep cañon gulch. The sample is clear and emits an odor of sulphuretted hydrogen, which is present in small quantity. The water has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	114.13	19.54
Soluble in water after evaporation	78.21	13.39
Insoluble in water after evaporation	28.50	4.88
Organic matter and chemically combined water	7.42	1.27
The soluble part consists of—		
Sodium and potasium sulphates (Glauber's salt, etc.)	68.39	11.71
Sodium chloride (common salt)	7.36	1.26
Sodium carbonate (sal soda)	2.48	.42
Magnesium sulphate (Epsom salt), small amount.		
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	22.66	3.88
Silica	5.84	1.00

The water is quite strongly mineral—quite ten times as much as should be the case for domestic use. Its character is that of a saline purgative, resembling somewhat the waters of Byron Spring. It contains a very large amount of Glauber's salt, a good deal of common salt, with a large amount of lime and magnesia carbonate and silica.

Water from a spring on Smith's Ranch, Alhambra Valley, four miles from Martinez, Contra Costa County; sent by Mr. L. M. Smith, Martinez:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	659.69	112.94
Soluble in water after evaporation	653.86	111.94
Insoluble in water after evaporation	5.83	1.00
Organic matter and chemically combined water, little.		
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	57.12	9.78
Sodium chloride (common salt)	399.77	68.44
Sodium carbonate (sal soda)	6.19	1.06
Magnesium chloride	8.65	1.48
Calcium chloride	182.13	31.18
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	5.37	.92
Silica	.46	.08

The very large amount of mineral contents condemns this water at once for domestic purposes. As a mineral water it is very strongly saline, with also nearly half as much chloride of calcium. The most delicate tests showed the presence of extremely small amounts of lithia. Its value for medicinal purposes is in great doubt.

Water from the tunnel in the hill at the Deaf, Dumb, and Blind Asylum, Berkeley; sent by Prof. W. Wilkinson, Superintendent.

Water from Strawberry Cañon; in use by the University (from a previous report, for comparison). Both waters are clear, colorless, and tasteless.

	Asylum.		University.	
	Grains per Gallon.	Parts in 10,000.	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	19.22	3.29	14.21	1.01
Soluble in water after evaporation	8.24	1.41	5.22	.37
Insoluble in water after evaporation	10.98	1.88	8.99	.64
The soluble part consists of—				
Sodium and potassium sulphates (Glauber's salt, etc.)	4.29	.74	.27	.02
Sodium chloride (common salt)	2.71	.46	1.54	.11
Sodium carbonate (sal soda)	1.24	.21	.29	.02
Sodium silicate			3.12	.22
The insoluble part consists of—				
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	6.01	1.03	8.81	.62
Silica	4.97	.85		
Phosphate of iron and alumina			.18	.02

A comparison of the two waters, respectively, from the Asylum and University water-supply, is of interest in showing that while that of the former has much the larger amount of mineral matter, nineteen to fourteen grains, it is also much softer than that of the University, because of the less content of earthy matter; only six grains of the total nineteen of the Asylum water go to produce the "hardness," while nearly nine grains of the total fourteen of the University act in that direction. Moreover, there is four times as much carbonate of soda in the former (1.24 against 0.29 in the University water); and as sal soda is used for softening hard waters, that is a point in favor of the Asylum water. Both are, of course, good waters for all domestic uses.

Mineral water, taken from a spring six miles from Montecito Valley, Santa Barbara County; sent by Hon. E. H. Heacock. The sample was clear golden yellow in color, with a strongly bitter taste, and without odor.

"As a purgative water this is very effective and not painful in the least. It was a medicinal water used by the native Indians as a purgative and cure for most of their ills. It is estimated that the spring yields some five hundred gallons of water per day."

An analysis gave the following result:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	2,224.64	380.86
Soluble in water after evaporation	1,820.44	311.66
Insoluble in water after evaporation	83.88	14.36
Organic matter and chemically combined water	320.32	54.84
The soluble part consists of—		
Potassium sulphate	6.16	1.06
Sodium sulphate (Glauber's salt)	152.58	26.12
Sodium chloride (common salt)	242.88	41.58
Sodium carbonate (sal soda)	36.57	6.26
Magnesium sulphate (Epsom salt)	966.59	165.48
Magnesium nitrate	415.66	71.16
The insoluble part consists of—		
Calcium sulphate (gypsum)	57.12	9.78
Calcium phosphate	Trace.	Trace.
Magnesium carbonate	26.76	4.58

The composition of this water is very unusual. There are waters as strong as this in Epsom salt and the other saline ingredients given, but the extraordinary quantity of nitrate of magnesia shown here is quite out of the usual way, and would hardly be looked for outside of the nitre beds of Bolivia or Nevada.

In general saline strength the water is about equal to that of sea water. It is needless to say that with over fourteen hundred grains of magnesian salts per gallon it must be highly purgative, as Mr. Heacock says; but the cooling effect of the nitre may have something to do with the mildness or painlessness of the action referred to. As a very concentrated medicine, it should be used with great caution by patients. The yellow tint is doubtless due to dissolved organic matter of some kind, not easily identified; it is evidently dissolved in the carbonate of soda.

It would be highly interesting to ascertain the exact origin of this water, and the conditions under which so much nitre can be formed in the coast climate of Santa Barbara.

Waters from four springs in the cañons of Piru Rancho, near Camulos, Ventura County; sent by David C. Cook, Esq. The water from Spring No. 3 is colorless, and somewhat flattish to the taste. There was a slight evolution of carbonic acid when boiled. Spring water No. 4 is from the same locality, but sent more recently; the sample is clear, tasteless, and odorless.

	Spring No. 1.	Spring No. 2.	Spring No. 3.	Spring No. 4.	
	Grains per Gallon.			Grains per Gal.	Parts in 10,000.
Total residue by evaporation	85.10	181.60	57.25	61.68	10.5
Soluble in water after evaporation	47.31	87.70	21.62	24.19	4.1
Insoluble in water after evaporation	30.69	70.54	27.63	29.90	5.1
Organic matter and chemically combined water	7.10	23.36	8.00	7.59	1.3
The soluble part consists of—					
Sodium and potassium sulphates (Glauber's salt, etc.)				9.93	1.1
Sodium chloride (common salt)				1.84	.3
Magnesium sulphate (Epsom salt)				15.42	2.6
The insoluble part consists of—					
Magnesium carbonate				3.43	.5
Calcium carbonate, small amount.					
Calcium sulphate (gypsum)				21.92	3.7
Silica				4.55	.7

The *soluble part* of these waters consists of sulphates and bicarbonates of potash and soda, with a small amount of common salt. The *insoluble part* is principally gypsum, with carbonates of lime and magnesia, and a very little silica; traces of iron are present. The waters are very nearly of the same character, although of different degrees of strength. None of them fall within the limits of what is usually considered potable waters. No. 2 is unfit for any but medicinal use, permanently. No. 1 might, with proper precautions, be used for irrigation. No. 3, with its 21.6 per cent of permanently soluble alkali, is just admissible for ordinary irrigation. It is still two and one half times stronger than the Los Angeles River water, and six times stronger than that of Kern River; and it will necessitate special modes of culture to render it permanently innocuous. But if forming only a part of the supply of the reservoir otherwise filled with rain water, it may, of course, be diluted down to the regulation strength.

The water of the sample sent more recently (No. 4) contains a large amount of mineral matter, the greater part of which is gypsum and Epsom salt, with some Glauber's salt; it is therefore quite purgative in its nature, and, in its raw state, unfit for domestic uses; it may be improved for drinking by treatment with lime water, and for washing by the use of sal soda. It will do fairly well for irrigation.

Mineral water from the mountains some twenty-five miles east of San Buenaventura, Ventura County, at an altitude of about one thousand eight hundred feet above the sea; sent by Mr. José G. Moraga Santa Barbara. The sample sent is clear and colorless, but intensely saline to the taste. It contains 4,544 grains of residue per gallon, consisting mainly of common salt, with chlorides of calcium and magnesium in small quantities. There are also some carbonates of lime and magnesia, the former predominating, in the insoluble portion of the residue. This water is exceptionally strong in mineral contents, and of course is totally unfit for domestic use or for irrigation purposes, and too nearly pure salt water to promise unusual medicinal virtues.

Water from a spring six miles east of Sumner, Kern County; sent by Mr. John Barker, Sumner.

"The spring issues from under a bluff three hundred feet in height and flows into Kern River, which lies about ten feet below it. A continuous stream of gas-bubbles rises up through the water to the surface

The bluff is composed of a regular stratum of sedimentary deposit, which has evidently been formed at the bottom of an ancient sea, as fossil remains are found all through it. A heavy deposit of white sulphur exists for a long distance above and below the spring. The temperature of the spring is 70 degrees Fahrenheit. Many persons with malarial troubles have used the water, and claim to have been benefited."

The sample is clear, has a saline taste, and an odor of sulphuretted hydrogen.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	199.18	34.10
Soluble in water after evaporation	186.92	32.00
Insoluble in water after evaporation	7.30	1.25
Organic matter and chemically combined water	4.96	.85
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	15.72	2.70
Sodium chloride (common salt)	142.72	24.43
Sodium carbonate (sal soda)	28.48	4.87
The insoluble part consists of—		
Calcium and magnesium carbonates Calcium sulphate (gypsum)	4.67	.80
Silica	2.63	.45

The character of this water is that of a saline sulphur water of considerable strength. The chief ingredient is common salt; and, with the carbonate and sulphate of soda, it forms a composition that might be beneficial in many cases. But its exact uses must be pointed out by the doctors.

Water, stated to be from the water supply of the Soldiers' Home,* located between Los Angeles and Santa Monica, about three miles northwest of "The Palms" Station, Los Angeles County. The water rises in a loose sandstone formation in the Santa Monica Mountains. Sent by T. F. Laycock, Los Angeles.

	Grains per Gallon.	Parts in 10,000.
Total residue from evaporation	66.00	11.30
Soluble in water after evaporation	29.35	5.03
Insoluble in water after evaporation	25.85	4.42
Organic matter and chemically combined water	10.80	1.85
The soluble part consists of—		
Sodium chloride (common salt)	4.60	.79
Sodium and potassium sulphates (Glauber's salt, etc.)	7.32	1.34
Sodium carbonate (sal soda)	2.48	.42
Magnesium sulphate (Epsom salt)	14.45	2.48
The insoluble part consists of—		
Calcium sulphate	12.03	2.04
Calcium carbonate	9.90	1.69
Magnesium carbonate	2.72	.49
Peroxide of iron	Trace.	
Silica	1.20	.20

The high mineral contents of this water condemn it for domestic use, since Epsom salt, Glauber's salt, and gypsum comprise the chief ingredients and make it highly purgative in its nature. Even treatment with

* The authenticity of this sample is called in question by the authorities of the Home. On this point the station has no other information than that given by the sender; but, whatever may be its derivation, such water is most positively unfit for domestic use.

lime, as described in previous reports, would leave the water objectionable, though the removal of magnesia in that way would be a material improvement. The water is, therefore, unfit for habitual use, and if so used will necessarily produce serious disorders. It can be used for irrigation in sandy soils that are well drained, but in clay soils it will soon cause "alkali."

All the waters draining from the "rotten sandstone" of the region will probably be of the same nature, and wells should be bored down into the clay formations to get a reasonably good water.

Water and gas from a spring near Escondido, San Diego County; sent by Mr. J. W. Turrentine.

"The spring is located almost in the bed of Escondido River, not in the channel, but manifestly has no connection with the water of the river. The water seems to rise through a fissure in the granite from an unknown depth, and flows about one half of a miner's inch. The water, when entirely free from contamination, is soft, and apparently contains sulphur. Large quantities of gas or air escape continually; sometimes large bubbles are sent up, a few of which would fill a pint bottle. During the past three years there seems to have been no change either in the quantity or quality of the water."

The sample is clear, colorless, and tasteless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	24.94	4.27
Soluble in water after evaporation	15.71	2.69
Insoluble in water after evaporation	6.96	1.19
Organic matter and chemically combined water	2.27	.39
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	9.08	1.56
Magnesium sulphate (Epsom salt), small amount.		
Sodium chloride (common salt)	4.77	.82
Sodium carbonate (sal soda)	1.86	.32
The insoluble part consists of—		
Calcium and magnesium carbonates	5.96	1.02
Calcium sulphate (gypsum)		
Silica	1.00	.17

The gas that is given off is nitrogen, entirely neutral, and of no effect. The mineral contents are too small to entitle it to the name of mineral water, though such as there are will probably act as a gentle purgative on some persons; this property may also prevent its use for domestic purposes.

COMMON WELL WATERS.

Well water; sent by Dr. W. N. Finney, Roseville, Placer County. The water is from a bored well; the sample sent is clear, with a slight odor of sulphuretted hydrogen.

	Grains per Gallon.	Parts in 10,000.
Total residue from evaporation	39.25	6.72
Soluble in water after evaporation	26.58	4.55
Insoluble in water after evaporation	9.75	1.67
Organic matter and chemically combined water	2.92	.50
Silica	3.63	.62

More than two thirds of the soluble part consists of the sulphates of soda and potash, the rest comprising bicarbonate of soda and common salt, the former predominating.

The water is slightly purgative, owing to the presence of Glauber's salt, which, with the carbonate of soda, makes up the effective portion of the contents. It would hardly do for daily use, but would be useful medicinally in certain cases of disease.

Well water; sent by Mr. Dana Perkins, Rocklin, Placer County.

"The well is sunk in soft granite to a depth of thirty feet, to a hard granite bowlder, over which a small stream of water runs in; water also seeps in at about three feet from the bottom."

The sample is clear, colorless, and tasteless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	18.40	3.15
Soluble in water after evaporation	5.84	1.00
Insoluble in water after evaporation	8.47	1.45
Organic matter and chemically combined water	4.09	.70
Silica	4.21	.71

The soluble part consists chiefly of common salt, with small amounts of sulphates and carbonates of the alkalies. The insoluble part consists of silica with considerable gypsum, and small quantities of carbonates of lime and magnesia. The water is good for both domestic and irrigation purposes.

Well water; sent by Mr. A. H. Grossman, Napa. The water is clear, and has an odor of sulphuretted hydrogen.

	Grains per Gallon.	Parts in 10,000.
Total residue after evaporation	12.15	2.06
Soluble part after evaporation	1.75	.30
Insoluble part after evaporation	7.77	1.33
Chemically combined water and organic matter	2.63	.45
The soluble part consists of—		
Sulphate of soda and potash (Glauber's salt)	.04	.01
Carbonate of soda (sal soda)	.62	.11
Sodium chloride (common salt)	1.09	.18
The insoluble part consists of—		
Carbonate of lime and magnesia, Sulphate of lime	1.29	.22
Silica	6.48	1.11

The only unusual thing about this water is its high content of silica, which probably causes it to turn turbid in a peculiar way, and to incrust vessels. It possesses no medicinal virtue, and is simply a good water for domestic use. It resembles very closely that from the well of Mr. Zierngibl, of St. Helena (given in a previous report), both in total constituents and in the relative amounts of each.

Well water; sent by Mr. Rothwell Hyde, St. Helena, Napa County. The water is clear, colorless, and tasteless. It has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	8.29	1.42
Soluble part after evaporation	1.17	.20
Insoluble part after evaporation	5.54	.95
Chemically combined water and organic matter	1.58	.27
Silica	4.26	.73

This water is *very* weak in its mineral constituents, a little more than one half of which is silica. There is present about half a grain each of common salt and bicarbonate of soda, a very little Glauber's salt, and a little more than one grain of carbonate of lime and magnesia in a gallon of the water.

This water, like that from the well of Mr. Zierngibl, of St. Helena, and Hunziker's Spring, Cloverdale (see above), is quite peculiar, in that its chief mineral constituent is silica, while the permanently soluble portion is very small. If the insoluble portions were removed, by boiling or other means of precipitation, the water would be almost chemically pure. It is very good for domestic and all other uses.

Well water; sent by Mr. E. Younger, San José, Santa Clara County. "The water has a flow of six inches over a tin pipe from a well that is four hundred and fifty feet deep, the lower one hundred and eighty feet being through a rotten clay with streaks of rust, and inclosing large brownish-colored bowlders. The water when allowed to drip for any length of time upon substances, forms upon them a brownish deposit looking like rust; and when confined for some time in a closed vessel it acquires a very strong odor. Tender flowers will not stand being watered with it."

The sample received was clear, colorless, and odorless; also free from iron. An analysis shows it to have the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	20.15	3.45
Soluble in water after evaporation	8.18	1.40
Insoluble in water after evaporation	8.47	1.45
Organic matter and chemically combined water	3.50	.60
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	2.61	.45
Sodium chloride (common salt)	.68	.11
Sodium carbonate (sal soda)	4.89	.84
The insoluble part consists of—		
Calcium and magnesium carbonates Calcium sulphate (gypsum)	7.01	1.20
Silica	1.46	.25

The water agrees remarkably with those examined from artesian wells between San José and Alvarado, both as to amount of mineral matter and its nature. The predominance of carbonate of soda is characteristic of all the artesian waters coming from near the center line of the Santa Clara Valley. There is nothing against the water for domestic use; for irrigation, the carbonate of soda should be counteracted by the use of land plaster from time to time; but it is, in general, a very good

water. The coloration spoken of arises from a deposition of a mixture of silica and a little iron rust on the surface of tin or other articles that will show such change readily. Any water containing carbonate of soda is liable to put vegetable matter into a condition of offensive (lacto-butyric) fermentation, and hence the odor alluded to above. It will only happen when left stagnant, and means nothing to the detriment of the healthiness of the fresh water for drinking or other domestic purposes.

Water from a bored well near Cupertino, Santa Clara County; sent by Mr. F. Spangenburg.

"The well, seven inches in diameter, was bored on a wet spot to a depth of fifty-two feet, through ten feet of alluvial soil, thirty-six feet of yellow clay, impervious to water, but easily penetrated, three feet of blue clay, and three feet of blue gravel and stones. The well is situated at the outlet of a small ravine running north and south; the land on the east side of the ravine is hilly, and has a dark, clayey soil, mixed with enough gravel to prevent its being sticky. The land on the west side is gravelly. The watershed of this ravine covers fifteen or twenty acres. The wells on the adjoining places all have good water. The water in the pipe of this well stands fifteen inches above the surface of the ground, and is not influenced by wet or dry weather."

The sample of water sent is clear, colorless, and odorless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	46.73	8.00
Soluble in water after evaporation	12.85	2.20
Insoluble in water after evaporation	23.60	4.04
Organic matter and chemically combined water	10.28	1.76
Silica	8.52	1.47

The soluble part consists chiefly of common salt, with small amounts of the sulphates and carbonates of the alkalies, and a very small part of sulphate of magnesia (Epsom salt). The insoluble part consists chiefly of the carbonates of lime and magnesia, with some gypsum and silica. For domestic uses this water is but very slightly saline, but is somewhat hard from the presence of so much lime, etc. The latter could be removed by boiling or treatment with lime (see previous report), leaving behind only an unobjectionable amount of common salt. The water is quite well adapted to irrigation purposes, the lime and magnesia being advantageous, especially upon the clayey lands. The salt, while generally objectionable on such lands, is too little in amount to work any injury.

Well water from four miles southwest of Fresno; sent by Mr. I. F. Moulton, San Francisco. The water was taken at a depth of six feet (bottom water), and contained some suspended matter. The sample is clear and colorless, but saline to the taste.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	84.58	14.48
Soluble in water after evaporation	73.01	12.50
Insoluble in water after evaporation	6.89	1.18
Organic matter and chemically combined water	4.68	.80
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	60.63	10.38
Sodium chloride (common salt), chiefly		
Sodium carbonate (sal soda)	12.38	2.12
The insoluble part consists of—		
Calcium and magnesium carbonates	3.85	.66
Calcium sulphate (gypsum)		
Silica	3.40	.52

The water is quite saline in character, its mineral contents comprising chiefly common salt, with a considerable amount of Glauber's salt, and a small amount of sulphate of potash. There is also a considerable quantity of gypsum present. The water is unfit for either domestic or irrigation purposes, and when evaporated at the surface will produce "white alkali."

Well water, from the San Joaquin Valley Experiment Station, Tulare County; taken in December, 1889, and November, 1890. The samples sent were clear and colorless.

	Taken in 1889.		Taken in 1890.	
	Grains per Gallon.	Parts in 10,000.	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	11.45	1.96	11.97	2.05
Soluble in water after evaporation	2.78	.48	2.92	.50
Insoluble in water after evaporation	8.11	1.39	7.59	1.30
Organic matter and chem. com. water	.56	.09	1.46	.25
The soluble part consists of—				
Sodium and potassium sulphates	.44	.08	.80	.14
Sodium chloride (common salt)	.39	.07	.27	.04
Sodium carbonate (sal soda)	1.95	.33	1.85	.32
The insoluble part consists of—				
Calcium and magnesium carbonates	6.72	1.15	4.96	.85
Calcium sulphate (gypsum)				
Silica	1.39	.24	2.63	2.05

This water is remarkably weak in mineral contents, coming, as it does, from an alkali region. The ingredients are chiefly carbonates of lime and magnesia, but hardly in sufficient amounts to make the water "hard;" its saline contents are remarkably low. It is a good drinking water. Here, as elsewhere, surface water should be strictly excluded from bored wells, as it is intensely alkaline.

Water from a sump, fourteen feet deep, in the northwest (alkali) corner of the San Joaquin Valley Experiment Station grounds, near Tulare. The water is somewhat turbid, slightly alkaline to test paper, but with no odor or taste. This sump was dug with a view to testing the practicability of leaching out the alkali in the soil above, by flooding with water from the bored well of the station, which draws upon the supply found in gravel at depths from forty-five to sixty feet. The analysis of this water is given above.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	38.32	6.56
Soluble in water after evaporation	20.62	3.53
Insoluble in water after evaporation	12.79	2.19
Organic matter and chemically combined water	4.91	.84
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	8.90	1.52
Sodium chloride (common salt) and some nitrate	6.77	1.16
Sodium carbonate (sal soda)	4.95	.85
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum), a little	7.88	1.35
Silica	4.91	.84

As this sump is located in the "alkali corner" of the station grounds, in the bottom of a slough into which the surface water drains, it is probable that this water sample is stronger in alkali than the surface water at other points would be found to be. As it stands, however, the large percentage of mineral matter in this water renders it unfit for either irrigation or domestic use. The saline sulphates would soon prove injurious to man, while the carbonate of soda would produce "black alkali" on lands irrigated with the water. It is therefore desirable to exclude this surface water from the wells bored for either domestic or irrigation supply, as in fact is usually done in the region. As will be seen, its mineral contents exceed that of the well water over three times.

Water from a gas well, six miles east of Sumner (Bakersfield), Kern County; sent by Mr. John Barker.

"The well is situated on the bank of Kern River, some fourteen feet above low-water level, and three hundred yards from a gas and sulphur spring. The gas from the latter, collected in a reservoir three feet in diameter, and twelve feet in height constructed for the purpose, is sufficient to furnish one burner with a continuous supply, burning with a bright clear flame without smoke or odor. The well, ten inches in diameter, has been bored to a depth of fifty-three feet. The formation, from the surface down, is a sedimentary one, filled with marine fossils and petrifactions. The well was bored without difficulty for the first forty feet, when we encountered strata of what seemed to be a water formation of limestone filled with marine shells, and from three to twelve inches thick each; between these strata we find the same softer formation that exists near the surface (chalky rock). After penetrating this for thirteen feet a double casing of iron was put in. At the depth of twenty-two feet a strong flow of very strong sulphur water was struck, that rose four feet above the surface, and ran a stream over the top of the pipe-casing, equal to about three miner's inches; the water had a temperature of 80 degrees Fahrenheit, and is much stronger than

in the spring. The casing was then forced down twenty-two feet farther, but the water comes up with about the same volume on the outside of the casing. When the water was first struck at twenty-two feet there also came a very strong flow of gas, sufficient, I should think, to supply a large house with light and fuel."

The sample of water is clear, and has the odor of sulphuretted hydrogen. An analysis shows the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	163.38	27.97
Soluble in water after evaporation	147.48	25.25
Insoluble in water after evaporation	9.76	1.67
Chemically combined water and organic matter	6.14	1.05
The soluble part consists of—		
Sulphate of soda and potash (Glauber's salt)	22.99	3.95
Sodium chloride (common salt)	100.97	17.28
Bicarbonate of soda (sal soda)	23.52	4.03
The insoluble part consists of—		
Carbonate of lime and magnesia	5.55	.95
Silica	4.21	.72
Sulphuretted hydrogen, 2.73 cubic inches per gallon; free carbonic acid, very small amount.		

The character of the above is that of a strongly saline sulphur water. Without the sulphur it would be very much like a great deal of the alkali water that runs in some of the streams of Kern, San Luis Obispo, and Ventura Counties. With the sulphur, it may prove worth developing for curative purposes if the latter proves constant and strong. It is, of course, altogether too strongly mineral for domestic use.

Well water from Miramonte Colony; sent by Mr. George A. Raymond, Miramonte, Kern County.

"The well is twenty-two feet deep, and the water rises to within seven feet of the surface. A flow was struck at about thirteen feet, but the quantity was very small."

The sample is clear and colorless.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	8.18	1.40
Soluble in water after evaporation	4.67	.80
Insoluble in water after evaporation	2.34	.40
Organic matter and chemically combined water	1.17	.20
Silica	1.11	.19

Bicarbonate of soda is the chief ingredient of the soluble portion of the residue, the sulphates of soda and potash, with a little common salt, making up the remainder. The insoluble portion is about evenly divided between silica, on the one hand, and the lime and magnesia salts on the other. Altogether, it is a very good water for domestic use. It is a little purer than the Kern River water.

Well water, from a well twelve feet deep, on Sec. 3, T. 26, R. 23 E., northwest of Bakersfield, Kern County; sent by Mr. John S. Hittell, San Francisco. The water, on evaporation, was found to contain 1669.4 grains per gallon, which renders it entirely unfit for either domestic use or for irrigation purposes, being nearly two hundred times stronger than

Kern River water, and the ingredients almost wholly saline. Here, as at Tulare City, the surface waters should evidently be excluded from the wells bored for either domestic or irrigation supply.

Residues from water from bored wells, respectively on the places of Messrs. Connor and Willis Carter, near Livermore Ranch, Kern Island, Kern County. The residues were furnished by Mr. Carter.

	Connor's Place.		Carter's Place.	
	Grains per Gallon.	Parts in 10,000.	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	*3.04	.521	10.28	1.76
Soluble in water after evaporation	2.09	.358	5.86	1.00
Insoluble in water after evaporation	.61	.104	2.76	.47
Organic matter and chemically combined water	.34	.059	1.66	.28
Silica	.52	.088	1.52	.26

The water of each of these wells is very weak in its contents of mineral matter, that of Mr. Connor being especially so. In each the soluble alkali salts predominate, and in each the silica comprises the largest proportion of the insoluble part of the residue, though in that of Mr. Carter's well it is nearly equaled by the carbonates of lime and magnesia. In Mr. Connor's well the sulphates of soda and potash comprise nearly one half of the entire residue, or a little more than one grain per gallon, carbonate of soda being next. In that of Mr. Carter there is a little more common salt than of the sulphates of soda and potash, and the two make nearly one half of the entire residue.

The exceptional purity of these waters is quite remarkable, considering that the surface of the country is so commonly charged with alkali.

Water from a bored well in the Mojave Desert, about six miles east of Mojave, Kern County; sent by Mr. B. Marks, of San Francisco. The water was taken at a depth of one hundred and eighty-five feet, at which it was struck in large volume, rising twelve feet. When taken from the sand-pump it was thick and yellow, on account of the churning motion of the auger; it was allowed to settle and the water drawn off.

"The material penetrated by the well was a dry cement gravel, with layers of clay, and this has continued from the surface down to the depth of three hundred feet. There are no surface indications of alkali in that region."

The sample is clear, colorless, and tasteless; the analysis showed the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	20.26	3.47
Soluble in water after evaporation	4.20	.72
Insoluble in water after evaporation	11.62	1.99
Organic matter and chemically combined water	4.44	.76
Silica	6.30	1.07

The soluble portion consists of carbonate and chloride of sodium, with a small amount of sulphate of potassium. The insoluble part con-

*From data reported by Mr. Connor; probably too low.

sists mainly of silica, with a considerable quantity of lime carbonate, and a small amount of gypsum and carbonate of magnesia. This water is "hard" in character, from the rather large amount of lime and magnesia; these can be readily removed by boiling, or by treatment with lime, as recommended in a former report. The water is admirably suited for irrigation, and good for domestic use.

Well water; sent by Mr. F. C. Howard, Carisa Plains, San Luis Obispo County.

	Grains per Gallon.	Parts in 10,000.
Total solid residue by evaporation	348.31	59.63
Soluble part after evaporation	230.14	39.40
Insoluble part after evaporation	74.65	12.78
Chemically combined water and organic matter	43.52	7.45
The soluble part consists of—		
Sulphate of soda (chiefly), with an appreciable amount of sulphate of magnesia, and a small amount of sulphate of potash	216.20	37.02
Common salt	9.54	1.63
Bicarbonate of soda	4.40	.75
The insoluble part consists of—		
Carbonates of lime and magnesia and sulphate of lime (gypsum)	73.25	12.54
Silica	1.40	.24

The presence of so large an amount of the soluble sulphates of soda (Glauber's salt), magnesia (Epsom salt), and potash makes this water very strongly purgative, and entirely unfit for domestic purposes. With care, it can be used as a purgative medicine in certain diseases.

Well water, from a well on the San Juan Ranch; sent by Mr. William Kelly, Cholame, San Luis Obispo County. The water is clear and colorless, and has a strong odor of sulphuretted hydrogen. It has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	553.04	94.68
Soluble in water after evaporation	407.24	69.72
Insoluble in water after evaporation	70.21	12.02
Organic matter and chemically combined water	75.59	12.94
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	372.60	63.78
Sodium chloride (common salt)	27.21	4.67
Sodium carbonate (sal soda)	7.43	1.27
The insoluble part consists of—		
Calcium and magnesium carbonates Calcium sulphate (gypsum)	68.22	11.68
Silica	1.99	.34

This water is strongly medicinal in its character, its mineral ingredients consisting very largely of Glauber's salt, with much common salt, thus making it a saline purgative of considerable strength. It is entirely unfit for either domestic use or irrigation purposes.

Well water, from the west end of Ojai Valley; sent by Mr. K. P. Grant, Nordhoff, Ventura County. The sample is clear, colorless, and odorless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	24.18	4.14
Soluble in water after evaporation	8.47	1.45
Insoluble in water after evaporation	10.17	1.74
Organic matter and chemically combined water	5.54	.95
Silica	3.16	.54

The soluble portion is composed of a little more than three and one half grains of bicarbonate of soda, and of two and one half grains each of common and Glauber's salt. The insoluble portion comprises, besides the silica, seven grains of lime and magnesia carbonates and sulphates; these make the water "hard," but they can be precipitated by boiling, thus reducing the soluble constituents to 8.47 grains per gallon. This can also be done by the lime treatment, given on page 12 of the Report on Waters, etc., for 1886–1889.

This water is therefore quite within the received limits of good potable waters, and can be readily still further softened and purified.

Waters from the wells and streams of Nordhoff, Ojai Valley, Ventura County; sent by the Nordhoff Board of Health, for examination as to purity, it being the supposed cause of the sporadic occurrence of typhoid fever in that town, which obtains its water supply both from wells and from hydrant water conveyed from the mountains by pipe.

"*No. 1* is water from the hydrant or pipe. The stream from which it is taken is quite small (only about four inches at this season of the year, viz.: December).

"*No. 2* is from a well belonging to a family, two members of which are affected with the fever. This well is thirty-two feet deep, and has eighteen feet of water in it. The strata through which it is bored are as follows: Sandy soil, nineteen feet; gravel, two feet; red clay, six feet; gravel with water, three feet; red clay, two feet.

"*No. 3* is from another well belonging to a family, four members of which have the fever. The depth of this well is eighteen feet, with the following strata: Adobe soil, six feet; sand and gravel, twelve feet.

"*No. 4* is from a small stream, upon which is located a slaughter-house, which furnishes the town with meat. The cattle drink this water, and it is used also about the slaughter-house and on the meat at the time of killing."

	Total Solids.		Ammonia. Parts per 1,000,000.		
	Grains per Gallon.	Parts in 10,000.	Free.	Albuminoid.	Total.
No. 1—Hydrant water	46.50	7.96	.032	.036	.068
No. 2—Well water	70.09	12.00	.069	.064	.133
No. 3—Well water	43.22	7.40	.200	.200	.400
No. 4—Stream water	54.32	9.30	.050	.100	.150

All these waters contain a somewhat excessive amount of mineral salts; No. 2 more than *any* water for domestic use should have.

The determination of ammonia represents the greater or less contamination with the products of animal and vegetable decay. In Nos. 1 and 2 this does not exceed the limit usually allowed. No. 3 exhibits a

very decided and inadmissible excess of albuminoid contamination, and is not fit for either human or animal consumption. Water No. 4 is close to the allowable limit, and, if taken at a time when there was no special cause for contamination from the operations of the slaughter-house, is to be considered suspicious.

An analysis of the residue from well No. 3, whose water contains the greatest amount of ammonia, gave the following results:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	43.22	7.40
Soluble in water after evaporation	19.39	3.32
Insoluble in water after evaporation	18.10	3.10
Organic matter and chemically combined water	5.73	.98
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	10.35	1.77
Sodium chloride (common salt)	4.09	.70
Sodium carbonate (sal soda)	4.95	.85
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	13.31	2.28
Silica	4.79	.82

There is in this water enough of the soluble alkali sulphates (Glauber's salt, etc.) to render it somewhat debilitating to the system, if used constantly, and thus render more effective and dangerous the rather large amount of albuminoid ammonia present. The presence of so much common salt at the same time, suggests at once its contamination with sewage.

Altogether there is little doubt that the prevalence of typhoid fever in the two families was the result of the use of the water from their respective wells, and especially so from well No. 3.

Well water; sent by Mr. J. William James, Los Angeles.

"The well is one hundred and two feet deep, and cased with double iron pipe. Water was reached at seventy-five feet; boring was continued through a small bed of clay, then through eighteen feet of fine sand, and finally through clay again; the water then rose in the pipe to within twenty feet of the surface."

The sample of water sent is clear, colorless, and tasteless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total solid residue by evaporation	39.83	6.82
Soluble part after evaporation	13.43	2.30
Insoluble part after evaporation	15.07	2.58
Combined water and organic matter	11.33	1.94
Silica	2.92	.50

The soluble part consists of about equal portions of common salt, bicarbonate of soda, and sulphates of soda and potash; the insoluble part contains about three grains of silica per gallon, the rest being the carbonates of lime and magnesia, and sulphate of lime (gypsum). This is a very hard water, and likely to disagree with many persons, unless purified by boiling, or by treatment with lime, as recommended in the previous report on waters, etc.

Well water, from the Blaisdell Ranch, in the valley of Gila River; sent by Mr. Hiram W. Blaisdell, Yuma, Arizona.* The waters are clear and tasteless, but slightly flattish on the tongue.

	Grains per Gallon.				Parts in 10,000.			
	Sample taken June 6	Sample taken June 23	Sample taken Aug. 9	Sample taken Dec. 15	Sample taken June 6	Sample taken June 23	Sample taken Aug. 9	Sample taken Dec. 15
Total residue by evaporation	41.6	44.2	42.5	37.3	7.12	7.56	7.28	6.38
Soluble in water after evaporation	30.4	32.2	30.7	29.1	5.20	5.52	5.24	4.98
Insoluble in water after evaporation	8.8	8.9	9.4	5.0	1.48	1.52	1.60	.86
Organic matter and combined water	2.4	3.1	2.4	3.2	.44	.52	.44	.54
The soluble part consists of—								
Sodium and potassium sulphates, Sodium chloride (common salt)	26.7	28.5	26.9	22.6	4.76	4.88	4.57	3.88
Sodium carbonate (sal soda)	3.7	3.7	3.8	6.5	.64	.64	.66	1.10

The insoluble part of these waters consists of carbonates of lime and magnesia, silica, and a very little sulphate of lime (gypsum); also traces of iron, alumina, and phosphoric acid.

The soluble salts exceed, in the months mentioned, what is usually deemed admissible in waters for permanent irrigation, unless special measures be taken to remove the salts from time to time. The presence of carbonate of soda should be counteracted by the use of plaster—say one hundred pounds the first year, and half that amount each succeeding year. The soil is so porous that a leaching out of accumulated salts would seem to be easy by thorough flooding in winter.

D. ARTESIAN WATERS.

Water from an artesian well on an island in the middle of Suisun Bay; sent by Mr. J. W. Dutton, Dutton's Landing, Solano County. "This water came from a depth of two hundred feet below the surface, and was pumped up with a deep-well pump through a two-inch pipe. The water in the well rises to within twenty inches of the surface. The strata passed through in this well are as follows: A heavy clay soil or slickens from eight to ten inches deep, underlaid by a half decomposed vegetable-rooty peat to a depth of seventy feet; near the bottom of the latter, mud of a bluish nature is found. To a depth of one hundred and eighty to two hundred feet there are layers of dark sand and gravel, alternating with blue clay, from seven to ten feet each; the lower strata of the latter are very firm, and sometimes nearly as hard as dry putty. In some cases we have found a yellow clay, under which the best water was had. If we go below two hundred feet the strata average about the same, with gravel somewhat coarser, to a depth of three hundred and ten to three hundred and thirty feet, where a stratum of white sandstone, or a kind of limestone, occurs, under which water is found very strongly charged with sulphur; on opening a bottle of it, after being sealed for twenty-

* Analyzed at the request and expense of the sender.

four hours, a very decided odor of sulphuretted hydrogen gas is perceptible. Cattle drink it ravenously and seem to thrive on it well."

The sample is clear and colorless, and an examination shows it to have the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	83.82	14.35
Soluble in water after evaporation	54.32	9.30
Insoluble in water after evaporation	19.86	3.40
Organic matter and chemically combined water	9.64	1.65
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	1.87	.33
Sodium chloride (common salt)	45.00	7.70
Sodium carbonate (sal soda)	7.45	1.27
The insoluble part consists of—		
Calcium and magnesium carbonates Calcium sulphate (gypsum)	16.59	2.84
Silica	3.27	.56

The water is rather strongly saline, more than one half of its mineral contents consisting of common salt; it seems to be only diluted sea water. It is unfit either for domestic use or for irrigation.

Water from a flowing gas-well in Sacramento; sent by the "Sacramento Natural Gas Company."

"The well is three hundred and eighty feet deep, the following strata having been passed through:

Loam and sand	31 feet.
Bluish sand	16 feet.
Gravel and cobblestones	54 feet.
Alternating beds of clay and sand	4 feet.
Sandy cement	42 feet.
Blue clay	57 feet.
Clay and sand in streaks	71 feet.

"The last stratum was a quicksand, underlaid with a thin clay sheet, followed by coarse sand, from which came a flow rising six feet eight inches above the surface of a low lot; the diameter of the pipe is eleven inches. A large quantity of gas accompanies the water."

The sample of water is clear, with a slight odor of sulphuretted hydrogen; its composition is as follows:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	28.91	4.95
Soluble in water after evaporation	13.72	2.35
Insoluble in water after evaporation	9.35	1.60
Organic matter and chemically combined water	5.84	1.00
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	8.99	1.54
Sodium chloride (common salt)	1.64	.28
Sodium carbonate (sal soda)	3.09	.53
The insoluble part consists of—		
Calcium and magnesium carbonates Calcium sulphate (gypsum)	4.15	.71
Silica	5.20	.89

This water differs rather markedly from the waters that usually accompany the gas around Stockton, which seem to be merely brackish waters slightly changed. Here the amount of common salt is quite

small, while, on the other hand, it contains enough sulphate of soda (Glauber's salt) to create discomfort with some persons who use it. It belongs to the same class of carbonate of soda waters that are found southward of Merced.

The mineral contents of the water are not large, and most people would quickly become accustomed to its use.

For irrigation the water would be good enough on sandy land, or even on well-drained loam land, but on heavy soils it would gradually cause alkali to accumulate.

Water from the artesian well at the Asylum for the Insane, Stockton; sent by Dr. H. W. Rucker, Medical Superintendent. The well was bored to a depth of one thousand and seventy feet.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	47.84	8.19
Soluble in water after evaporation	33.41	5.72
Insoluble in water after evaporation	9.41	1.61
Organic matter and chemically combined water	5.02	.86
The soluble part consists of—		
Sodium and potassium sulphates	1.52	.26
Sodium chloride (common salt)	22.92	3.79
Sodium carbonate (sal soda)	8.97	1.67
The insoluble part consists of—		
Calcium carbonate	1.30	.23
Magnesium carbonate	2.51	.42
Calcium sulphate (gypsum)	.40	.07
Silica	5.20	.89

The chief mineral constituent of this water is common salt, which, though not very excessive, injures what otherwise would be a very good water for domestic use. If used for irrigation purposes it would soon render a heavy soil saline; but on a porous soil, kept well tilled, it would doubtless do well with proper precautions.

Artesian water, from the waterworks at Stockton; sent by Mr. A. M. Noble, Secretary of the San Joaquin County Board of Trade. The source of the water is a deep bored well. The water is clear, tasteless, and odorless, and has the following composition:

Grains per Gallon.

Total	23.89
Again soluble after evaporation	11.51
Sodium carbonate (sal soda)	4.33
Sodium chloride (common salt)	3.41
Chlorine	2.07

Parts per Million.

Free ammonia	.250
Albuminoid ammonia	.124

So far as the mineral contents are concerned they do not differ materially, either as to quality or quantity, from the ordinary well and spring waters of the Coast Range, and notably of the Santa Clara Valley. It is somewhat hard, but well within the range of good potable waters.

Considering its origin from deep bored wells, the somewhat high proportion of free and "albuminoid" ammonia forms no objection, being referable to the solvent action of carbonate of soda upon the peaty sub-

strata of the valley; and therefore of no sanitary significance, here as elsewhere, so long as the water is not stored in large reservoirs so as to permit of the development of minute vegetable growth. Under such conditions it will be a good water for all domestic purposes.

Water from the artesian and gas well of St. Agnes Academy, Stockton; sent by Rev. W. B. O'Connor.

"The well is one thousand three hundred and fifteen feet deep, the last fifteen feet being in a bed of coarse gravel, round and smooth, as if worn by the action of a mountain stream."

The sample is clear and colorless, with a decided saline taste.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	174.94	29.9
Soluble in water after evaporation	135.75	23.2
Insoluble in water after evaporation	15.83	2.7
Organic matter and chemically combined water	23.36	4.0
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.), small. Sodium chloride (common salt)	132.63	22.7
Sodium carbonate (sal soda)	3.12	.5
The insoluble part consists of—		
Calcium and magnesium carbonates. Calcium sulphate (gypsum), little	10.28	1.7
Silica	5.55	.9

The mineral matter in this water is very large, and consists mostly of common salt, as is the case with most of the gas wells of this State; in fact, the composition of these waters is practically that of slightly brackish tidewater. The amount of salts in it is such that it could not be used for irrigation, save perhaps in sandy soils, well under-drained naturally. On heavy soils it would quickly render the land unfit for cultivation, since it contains quite ten times as much salt as is usually considered admissible, and over twenty times as much as the water of Mokelumne River.

Water from an artesian well on the ranch of Mr. H. T. Emeric, San Pablo, Contra Costa County. The water was obtained at a depth of one hundred and seven feet. The following strata were penetrated: Black soil, gravel, yellow clay, cement rock, and gravel; in the latter the water was found. The sample is clear and colorless.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	27.45	4.7
Soluble in water after evaporation	12.85	2.2
Insoluble in water after evaporation	9.93	1.7
Organic matter and chemically combined water	4.67	.8
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	3.25	.5
Sodium chloride (common salt)	3.41	.5
Sodium carbonate (sal soda)	6.19	1.0
The insoluble part consists of—		
Calcium and magnesium carbonates. Calcium sulphate (gypsum)	8.18	1.4
Silica	1.75	.3

The water contains a rather large amount of saline matter, but not enough to be injurious for ordinary uses. It will be a little

"hard" from the presence of the carbonates of lime and magnesia, but these can be removed by boiling or by adding a little lime water, say one twentieth, and letting it settle. The carbonate of soda may render it a good water for acid dyspepsia, but it is not strong enough to be medicinal, properly speaking.

Water from an artesian well in Goshen, Tulare County; sent at the request of Dr. C. F. Buckley, San Francisco. The sample of water is clear, colorless, and tasteless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	9.64	1.65
Soluble in water after evaporation	5.84	1.00
Insoluble in water after evaporation	2.34	.40
Organic matter and chemically combined water	1.46	.25
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	1.09	.19
Sodium chloride (common salt)	.42	.07
Sodium carbonate (sal soda)	4.33	.74
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	.94	.16
Silica	1.40	.24

The water is rather remarkably pure, especially considering the alkali nature of the region where it was bored. It is very nearly like the water of Kern River—if anything, a little purer. It is good both for domestic use and for irrigation purposes. Here, as elsewhere, surface water should be strictly excluded from bored wells, as it is intensely alkaline.

Water from an artesian well at Hanford, Tulare County; sent by R. W. Musgrave.

"The water comes from a depth of one thousand one hundred and fifty feet, and has a medicinal effect on some persons. The well has been bored through an immense stratum of sand to a clay."

The water is clear and tasteless.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	15.18	2.60
Soluble in water after evaporation	14.31	2.45
Insoluble in water after evaporation	.58	.10
Organic matter and chemically combined water	.29	.05
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	1.46	.25
Sodium chloride (common salt)	5.42	.93
Sodium carbonate (sal soda)	7.43	1.27
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	.30	.06
Silica	.28	.04

The amount of mineral matter in this water is rather small, and consists almost exclusively of alkali salts, chiefly common salt and sal soda, which, in such small quantities, are not prejudicial to its domestic use. The surface waters of the region usually differ from it in being of a much more saline and purgative character.

Artesian water from the reservoir on Richard Gird's ranch, Chino, from which the water supply for South California Experiment Station, near Pomona, is drawn. The sample is clear, colorless, and tasteless.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	11.94	2.04
Soluble in water after evaporation	3.03	.52
Insoluble in water after evaporation	7.92	1.35
Organic matter and chemically combined water	.99	.17
The soluble part consists of—		
Sodium sulphate (Glauber's salt)	1.25	.22
Potassium sulphate	1.05	.18
Sodium chloride (common salt)	.26	.04
Sodium carbonate (sal soda)	.47	.08
The insoluble part consists of—		
Calcium carbonate	4.54	.78
Magnesium carbonate	1.30	.22
Calcium sulphate (gypsum)	.53	.09
Silica	1.55	.26

This is an excellent water for both domestic use and for irrigation. At the rate of one tenth of an inch per acre it will supply about sixty-two pounds of potash sulphate annually, being more than most crops require, and worth at wholesale $1 85.

Water from an artesian well at San Bernardino; sent by Mr. W. H. Avery, Los Angeles.

"The well is one hundred and eighty feet deep, and is one of the seven similar wells located at the foot of the mountains six miles northeast of the city of San Bernardino. The temperature of the water is 84 degrees Fahrenheit. This water is used for the irrigation of citrus trees on the granite soil at the base of the mountains. It is considered unsuitable for domestic use, producing slight sickness, and not so effectually quenching the thirst as other waters."

The water is clear, colorless, and odorless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	15.77	2.70
Soluble in water after evaporation	11.56	1.98
Insoluble in water after evaporation	1.70	.29
Organic matter and chemically combined water	2.51	.43
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	5.33	.91
Magnesium sulphate (Epsom salt), small amount.		
Sodium chloride (common salt)	1.34	.23
Sodium carbonate (sal soda)	4.89	.84
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	1.40	.24
Silica	.30	.05

This water is weak in mineral matter, but the greater part of this consists of Glauber's salt and sal soda, with a little Epsom salt, which would together, doubtless, affect some persons as a mild laxative; otherwise it is suitable for all domestic uses. In view of its somewhat considerable proportion of carbonate of soda, its continued use on soils not very pervious will, after awhile, require the use of gypsum as an antidote.

Water from an artesian well south of Santa Ana; sent by Mr. C. T. Hopkins, Pasadena, Los Angeles County. The well is in a region of moist adobe lands, whose ground-water is within a foot of the surface. The sample of water is clear, colorless, and tasteless, and has the following composition:

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	24.59	4.21
Soluble in water after evaporation	11.68	2.00
Insoluble in water after evaporation	6.31	1.08
Organic matter and chemically combined water	6.60	1.13
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	7.29	1.25
Sodium chloride (common salt)	.68	.11
Sodium carbonate (sal soda)	3.71	.64
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum), very small	5.14	.88
Silica	1.17	.20

The mineral matter in this water is not very large, although the Glauber's salt present might act as a slight purgative with some persons at first. For irrigation purposes it is a little stronger in alkali than is desirable upon adobe soil, though it will do upon well-drained lands. This is one of a number of wells that have been allowed to "run wild" on these coast lands for a number of years, and although not at all strongly alkaline in themselves, have converted an originally non-alkaline soil into an alkali swamp, on which it is difficult to grow anything useful. It is, of course, quite feasible to reclaim these lands by capping the wells and draining; and there ought to be regulations prohibiting the running to waste of water from artesian wells, both for the preservation of the artesian supply and for protection against such injury as has occurred here.

Water from the artesian well at Elsinore, San Diego County; sent by Mr. E. Z. Bundy.

"The well is one hundred and twenty-five feet deep and seven inches in diameter. At one hundred and twenty feet, in a gray granite, water was struck which flows forty-four gallons per minute, and has a temperature of 110 degrees Fahrenheit. The water is used for drinking and bathing purposes by one half of the citizens of Elsinore."

The sample is clear, and has a taste of sulphuretted hydrogen.

	Grains per Gallon.	Parts in 10,000.
Total residue by evaporation	19.28	3.30
Soluble in water after evaporation	12.85	2.20
Insoluble in water after evaporation	5.55	.95
Organic matter and chemically combined water	.88	.15
The soluble part consists of—		
Sodium and potassium sulphates (Glauber's salt, etc.)	5.02	.86
Sodium chloride (common salt)	1.64	.28
Sodium carbonate (sal soda)	6.19	1.06
The insoluble part consists of—		
Calcium and magnesium carbonates, Calcium sulphate (gypsum)	2.04	.35
Silica	3.51	.60

The total mineral matter in this water is about the same as in th supplied to the city of Los Angeles from the Los Angeles River, b differs materially in kind, being not nearly so hard; *i. e.*, containi much less of lime and magnesia, but considerably more of carbonate soda. The latter prevents the slightly purgative action that might expected from the Glauber's salt. The water is therefore entire unexceptional for domestic use. If used for irrigation, it would necessary to offset the "black alkali" (carbonate of soda) that wou gradually accumulate in the soil, by an occasional dressing of gypsu or land plaster.

III. ANALYSES OF ROCKS, CLAYS, MARLS, PEAT, GYPSUM.

"*Phosphate rocks*" (two samples); sent by Mr. Samuel Cassidy, Petaluma, Sonoma County. "How much phosphoric acid is there in the samples?"

An analysis showed the presence of only eight hundredths (.08) of one per cent in one of the samples; and in the other, sixteen hundredths (.16) of one per cent. These amounts are not more than is found in ordinary soils.

Soft limestone; sent by the Germain Fruit Company of Los Angeles. "How much phosphoric acid does it contain?"

The material is chiefly carbonate of lime, with thirty-six hundredths (.36) of one per cent of phosphoric acid, and nearly three (2.98) per cent of silica. The amount of phosphoric acid is extremely small, and would not justify its use as a fertilizer. Some good soils contain nearly as much as does this limestone.

Rock and clay from near Santa Barbara; sent by Mr. J. C. Merrill, of Los Angeles, for examination, to ascertain its adaptability for the manufacture of Portland cement. "There is quite a ledge of the rock near Santa Barbara."

An examination showed that the *rock* contains very little carbonate of lime, and is chiefly an *infusorial earth.* The *clay* is simply an adobe, containing 10.88 per cent of carbonate of lime. Neither material is of value for the making of Portland cement.

"*Cement rock;*" sent by Messrs. Fraser Bros., of South Riverside. It was found to contain:

Calcium carbonate	59.99
Calcium sulphate (gypsum)	.15
Magnesium carbonate	9.79
Clay and silex (mostly the latter)	22.67
Iron and alumina	4.00
Volatile matter and chemically combined water	1.88
Total	98.48

There is too much magnesia in the rock; and an examination of the insoluble residue under the microscope shows that instead of being chiefly clay, as it should be, it is prevalently a very fine silex only. The tests made as to its setting qualities resulted very unfavorably, for there seem to be no hardening qualities whatever in the burnt mass. The material thus affords no advantages for the manufacture of Portland cement, the presence of so much magnesia alone disqualifying it from use as a cement material.

Clay and limestone from near Riverside, San Bernardino County; sent by Mr. Francis Cuttle, for examination as to their fitness for the manufacture of hydraulic cement.

The clay is greenish in color, and is slightly gritty to the teeth; softens quickly under water and becomes fairly plastic. The limestone (marble) contains a small amount of carbonate of magnesia. The composition of the air-dried clay is as follows:

Insoluble matter	30.85	55.67
Soluble silica	24.82	
Calcium sulphate (gypsum)		3.1
Magnesia (carbonate of magnesia)		5.6
Carbonic acid (carbonate of magnesia)		6.5
Peroxide of iron		6.1
Alumina		10.1
Alkalies, etc.		2.1
Water and organic matter		10.6
Total		100.0

The clay is near the lower limit of adaptable materials, since, when calculated to the dry substance, the alumina stands within a fraction of a per cent of the Medway clay, which is used for the original Portland cement. It, however, differs in other respects, and its precise qualities cannot be predicted without a practical trial. The limestone, while rather hard to grind fine enough, is sufficiently pure, and may be used experimentally in the proportion of a little more than two to one of the clay.

Clay from near Bakersfield; sent by Mr. Geo. Johnston, San Francisco, to be examined with respect to its possible fitness for fining wines.

The clay underlies the deposit of gypsum; it has a light bluish tint, and is gritty to the teeth, due to the presence of fine sand. A decided clay odor was perceptible on boiling the sample with water; after six hours' boiling the odor practically disappeared. An examination shows the clay to contain:

Silica, sand, etc.	75.00
Lime	.50
Alumina, with some ferric oxide	24.50
	100.00

The first requirement with respect to the fining of wine is that the clay should not impart the "clay" taste to the wine. This condition is fulfilled by the sample only after six hours' lively boiling, which is a long time. Still, steam is cheap, and it might be done. Its content of one half (.50) of one per cent of lime is within the limits of the Spanish fining clays; and so are the amounts of iron and alumina. Apart from the taste, then, this clay might do for fining.

Marl ("shell lime"); sent by J. DeBarth Shorb, Esq., San Gabriel, Los Angeles County, to be examined for phosphoric acid.

The marl contains 60 per cent of carbonate of lime, and only twenty hundredths (.20) of one per cent of phosphoric acid. A conglomerate that accompanies it has the same amount of lime, and only ten hundredths (.10) of one per cent of phosphoric acid. The two samples are therefore of no value as far as regards their content of phosphoric acid. Upon soils deficient in *lime*, their application would doubtless be attended with good results.

Peat; sent by Mr. C. J. Davis, Colton, San Bernardino County.

"The deposit, or rather accumulated growth, is found on the level ground, away from any wash, and lies in a somewhat circular area with a level surface, which is about five feet above the surrounding country. Springs are yet forcing their waters up to the top of the deposit, but the flow sinks again before reaching the edges of the bank. It is at least eight feet deep. Citrus growers have for years been putting this peat in the bottom of the holes in which the young trees are planted,

and are loud in their praise of its qualities. I think that the Colton terrace soils will be greatly benefited by it; and all soils, not adobe, upon which it has been used seem to retain moisture better for its presence; the trees are very dark green, with good growth and strong branches."

The sample is brownish black in color, and, air-dried, yields:

Organic matter, etc.	90.44
Ash	9.56
	100.00
Ammonia, ready formed	.04

The ash contains:

Soluble matter	1.70
Insoluble matter	7.86

The soluble part of the ash consists almost wholly of gypsum; the insoluble part consists chiefly of silica, with some gypsum and sand.

The fresh mass sent contains three fourths of its weight of water, and practically half of this is retained on drying, this being due to the great absorptive power of humus for moisture as well as for other gases. Of course this will, so far as it goes, render it valuable for droughty (very sandy) soils, in increasing their retentiveness. The available nitrogen (ammonia) is very small, hardly enough to be considered, as it would only amount to eight pounds in a ton of the raw material (value, about $1). Of course there is more nitrogen in the peat, but it is in the inactive form in which it exists in common humus, and of no definite value, save in the long run.

Of other useful ingredients, the important phosphates and potash compounds are present in traces only. The soluble part of the ash consists essentially of gypsum, with a little common salt, some lime, and carbonate of soda.

As a direct fertilizer, then, the material can be seriously considered, only in the case of soils very deficient in vegetable matter, such as the mesa soils around Colton and elsewhere, where the increase of retentiveness would be an important consideration. In any case it would of necessity have to be used in connection with some lime, marl, or wood ashes, to neutralize its acidity. But as a material for making composts, and for retaining the valuable liquid and gaseous portions of the manure, which are commonly lost from the manure pile, the peat would be of great usefulness. For that purpose it should be allowed to dry, and then used with other litter, as a most effectual absorbent.

Peat, from the San Bernardino Valley; sent by Mr. Wm. H. Avery, Los Angeles, to ascertain its value as a fertilizer. It is formed in "cienegas," chiefly from the roots of grasses. Its composition is as follows:

Organic matter, etc.	35.70
Ash	64.30
	100.00
Nitrogen, total	1.31

In the ash were found:

Phosphoric acid	.36
Soluble potash	.06

There is not enough of active nitrogen, phosphoric acid, and potash in this material to make it of value as a fertilizer. On general principles the peat is valuable as an absorbent for use in stables, corrals, etc.; and, when used with lime or marl, cannot fail to work a great improvement on the mesa soils of that region in supplying humus to them. It would be of little value upon moist lands, in which humus is, as a rule, abundant. The nitrogen of peat is well known to be in a very inert condition naturally, but becomes gradually available when subjected to the action of carbonate of lime, such as marls, plastering, etc.

Gypsum; sent by the Alpine Plaster and Cement Company, Los Angeles. "The material is very slow-setting, and when mixed with sand makes a very fine wall plaster. It is not a rock, but can be shoveled like earth. It sets under water, but will not stand the effect of running water. Will it make a cement for walks in the place of Portland cement?"

An examination showed the following composition:

Calcium sulphate (gypsum)	94.60
Clay	1.35
Sand	.23
Carbonates of lime and magnesia, and moisture	3.82
	100.00

This sample is practically pure gypsum, the impurities contained in it not being such as to materially change its character as plaster. It is just possible that there may be a slight addition to the final hardening, from the presence of a little clay and carbonate of lime, forming a hydraulic cement when burned together; but the presumption is that when the material is burned high enough for cement the plaster is overburned, and *vice versa*. For all practical purposes the material is plaster, pure and simple, which is soluble in water, and therefore can not be made to resist running water, unless impregnated with some water-proof material, such as asphalt; the latter, of course, can only be applied after the cast is made and dried.

Gypseous clay from near Riverside; sent by D. L. Wilbur, Esq., Riverside, to have its value as a fertilizer ascertained.

The clay contains 48.9 per cent of gypsum, and is, to that extent, available for the correction of "black alkali."

Gypsum; sent by T. H. Keeney, San Francisco. "Will it answer as a fertilizer, or an antidote for alkali lands?"

The air-dried sample, on analysis, was found to have the following composition:

Sulphate of lime (gypsum)	72.16
Carbonate of lime	3.16
Sand and silica	7.90
Clay, water, etc.	16.78
	100.00

The percentage of gypsum is below the average of the samples heretofore examined from the Bakersfield deposit, which was about 85 per cent, but for all that the material will serve as good a purpose, the only difference being that a larger quantity will have to be hauled.

Numerous other samples of gypsum, calcite, and other rocks and minerals have been determined mineralogically, without analysis.

IV. ALKALI.

ALKALI; ITS NATURE, CAUSES, AND REPRESSION.*

By E. W. HILGARD.

[It should be premised that, as stated in previous publications, no signs of alkali existed in the Fresno plateau—the divide between the San Joaquin and Kings Rivers—at the time the region was settled some sixteen years ago, nor for some time thereafter. Small spots of alkali gradually made their appearance in the older settlements, and visibly enlarged from year to year, finally causing vines and trees in the center of the spots to sicken and die. This state of things has now attracted the serious attention of the progressive inhabitants who do not intend to sell out, but to preserve a good heritage for their children or successors. It was by the request of a number of these that this lecture was prepared and delivered.]

The first point to be discussed in considering the subject I have been asked to bring before you is "*What is alkali?*"

The chemist will tell you that it consists of soluble compounds—salts—the basis of which is mainly soda, together with smaller amounts of potash, and usually a little lime and magnesia. When these salts are present in the soil to any considerable extent, their presence becomes manifest, in summer, by their appearance on the soil-surface in the form of white crusts or crystals. These represent mainly the following compounds: Sulphate of soda, or Glauber's salt, which is sometimes used as a medicine for cattle and horses; chloride of sodium, or common salt, which you know too well to require description; and last, but not least, carbonate of soda, or sal soda (washing soda), with which you are almost equally familiar. With these predominant salts, which are nearly always present in varying proportions, there are, in much smaller amounts, other salts highly important for vegetable nutrition, namely: sulphate of potash, phosphate of soda (or of lime), and very often nitrate of soda or Chile saltpeter; all ingredients of commercial fertilizers, the presence in which determines their value, and which are of prime importance to plant growth. With these we find usually to a greater or less extent Epsom salt, or sulphate of magnesia, and a little gypsum or sulphate of lime.

Next comes the question: "*How do these alkali salts get into the soils?*"

The reply is, that all soils are formed from rocks in which these substances occur in various forms, by the combined chemical action of air and water, and by mechanical pulverization by frost, flowing water, and moving ice, or glaciers. The same alkali salts are formed everywhere in the world; but in countries having abundant rainfall they are currently washed, as formed, into the country drainage, while in regions where rainfall is deficient, the scanty moisture only carries them a little way down into the subsoil, from which they rise to the surface by the evaporation of the water, and are thus accumulated at, and close to, the

* Synopsis of a lecture given at the Farmers Institute held at Fresno, April 3, 1891.

very top of the soil. It is right there that nearly all the damage is done; the water in the depths of the soil is very rarely strong enough to hurt the roots of plants, directly.

It follows from what I have said that "*all natural waters must contain alkali salts*" *to a greater or less degree.* That this is actually so can be seen from the table below, which shows the composition of a number of rivers in your valley and elsewhere, by giving, in grains per gallon, the amount of each of the salts present. Taking into consideration, for our purpose, only the soda and potash compounds here shown, it is seen that the purest water, from this point of view, is that of the Mokelumne; next in purity comes that of Kings River, which runs in your ditches; the largest amount of alkali is shown by the water of Kern River. It is the evaporation, for countless ages, of the Kern River water that has filled the lake basins of the upper San Joaquin Valley with waters now so strong in alkali that to use them for irrigation would be to quickly fill the lands on which they are used, with more alkali than would be compatible with crop-bearing.

ANALYSES OF WATERS FROM THE SAN JOAQUIN VALLEY.

Grains per Gallon.

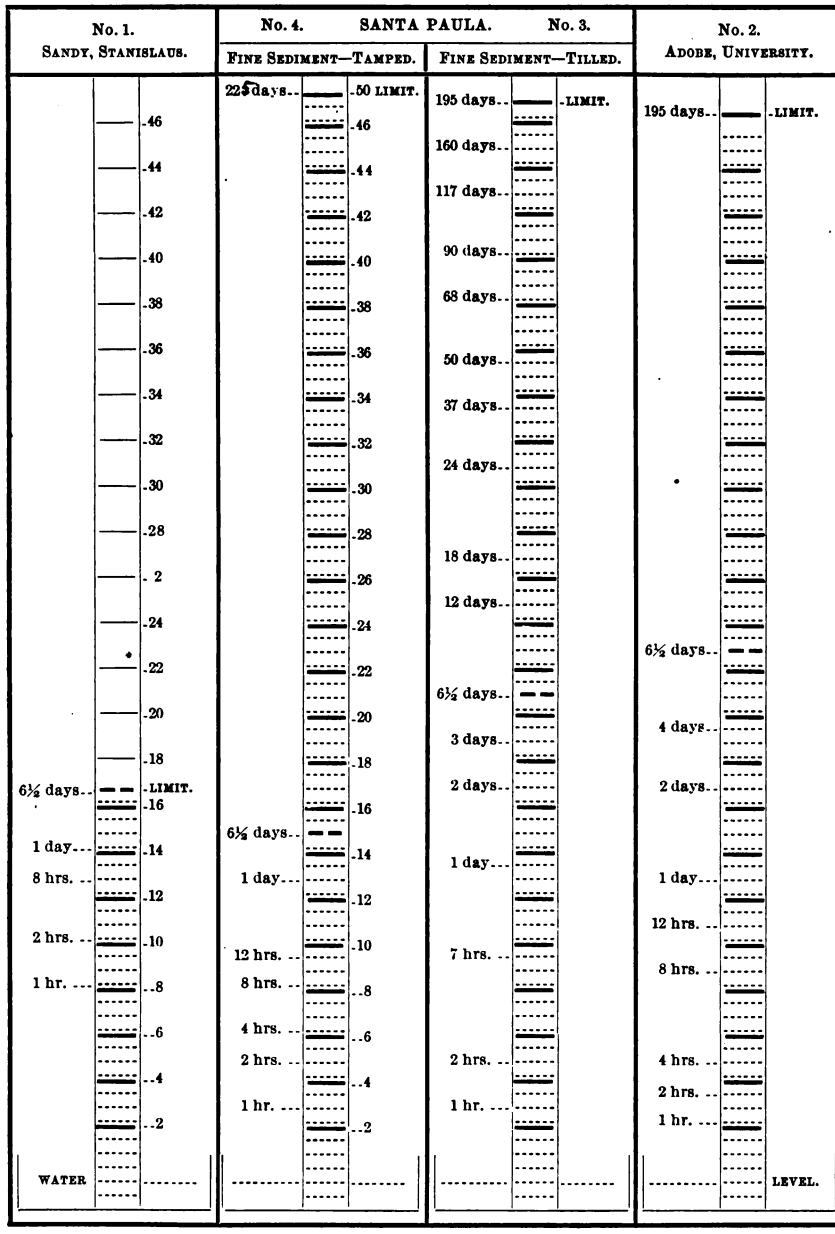
	Total Residue.	Carbonate of Soda.	Common and Glauber's Salt, etc.	Carbonates of Lime, Magnesia, and Silica.	Vegetable Matter.
1. Los Angeles River	17.53	----------	8.37	9.16	----------
2. Kern River (cañon)	9.49	1.22	1.77	5.55	0.95
3. Kern River (ditch)	9.62	1.23	2.21	5.33	0.85
4. Kern Lake	211.50	64.37	115.41	9.29	22.43
5. Tulare Lake (south end)	84.44	27.92	37.85	13.44	2.23
6. Tulare Lake (middle, surface)	81.95	35.30	35.96	5.37	5.32
7. Tulare Lake (middle, 10 feet below surface)	81.83	30.46	39.49	7.47	4.41
8. Tulare Lake (middle, 20 feet below surface)	81.72	----------	----------	----------	----------
9. Tulare Lake (near mouth of Kings River)	38.55	13.46	15.01	5.11	4.97
10. Tulare Lake (near outlet of west side canal, 10 feet below surface)	76.00	30.95	33.95	6.60	4.50
11. Kings River (June)	4.13	0.00	0.86	3.27	----------
12. Kings River (November)	5.03	----------	----------	----------	0.19
13. San Joaquin River	4.54	0.45	0.15	2.15	0.89
14. Merced River	5.64	0.19	0.09	4.18	----------
15. Mokelumne River	6.97	----------	0.42	4.42	3.70
16. Sacramento River	6.69	0.27	1.42	5.00	----------
17. Point of Timber (San Joaquin delta), well water	67.75	10.83	48.41	7.41	1.10

"*How and why does alkali rise to the surface?*" As I have already said, it is surface evaporation that brings it up. The soil acts like a wick; and if you will take a lamp wick and plunge its lower end in salt water, while exposing the upper end to the air, you will quickly see an "alkali crust" forming on that end.

But you also know that different wicks will raise water or coal oil to different heights, according as they are closely woven or loose like candle-wicking. The close wick will raise the fluid higher, but it will rise to its highest point more slowly than when you use the loose wicking. Just so in soils—the close ones will raise the soil water from a greater depth than loose sandy soils, but the latter will bring it up much quicker to the full height to which it can rise at all.

TABLE

Showing Rapidity of Ascent of Water in Different Soils, and Limit of Same.



The diagram before you shows these differences. The coarse sandy soil from Stanislaus has, in six and a half days, sucked up the water to the full height of sixteen and a half inches, and has remained there. Within the same time the close adobe soil of our experimental grounds

at Berkeley has made the water rise to the twenty-three-inch mark, but it has taken it nearly two hundred days to reach the final maximum height of forty-six inches; and there are some soils in which water will, in the end, rise even higher—say to fully five feet.

You see, then, that if alkali water should stand in a sandy soil at the depth of two feet, very little of it would evaporate at the surface, and therefore alkali would show on the surface only slightly, or not at all; while from a clay soil having water even twice the depth, the evaporation from the surface would be brisk and continuous, and an alkali crust would promptly form. You know well from your experience that alkali is always worse on clay soils than on adjacent sandy ones.

Beyond question *the damage done by alkali (in at least nine cases out of ten) is due to accumulation at or near the surface.* When we examine the soil of an alkali spot for its alkali contents at various depths, we find five or six times as much in the first inch from the surface down as is contained in the bottom water, or at the depth of a few feet in the soil itself. The top crust is sometimes almost pure alkali salt, and it is no wonder that it should corrode the stem or root-crown, and weaken or kill the plant. It obviously follows that the first requirement in preventing damage from alkali, is to prevent surface evaporation as much as possible. The first condition in this regard is to lessen the formation of a surface crust; in other words, to keep the soil in deep, loose tilth, or else, to mulch it. In either case, surface evaporation is reduced to the lowest point practically attainable. Evaporation through the leaves of plants—for instance in an alfalfa field—brings up no alkali to hurt. *More than half of the alkali land in this State that people are afraid to touch, requires no other remedy than thorough, deep tillage, maintained at all times.*

But in bad cases other means are required; and this leads us to consider *which of the above salts is the most injurious.*

Your experience tells you that the worst alkali is the "black." Now what is black alkali, and why is it so called?

Not, as some have imagined, because of its moral turpitude, but because it causes blackish tinted puddles to stand on the ground, and, on evaporation, leaves black rings around the margin of the pool. When we analyze such blackish water we find that its chief ingredient is carbonate of soda—sal soda—and that the black tint is caused by the humus of the soil, which it has the power to dissolve. This in itself is a serious injury, for humus is one of the most important of soil ingredients. If held in solution, or washed away *through* the soil, the producing powers of the land are seriously impaired.

That, however, is not the end of the injury; for when accumulated by evaporation around the root-crown, it absolutely corrodes and dissolves the bark as it does the humus of the soil, causing a dead ring around the butt, and finally girdling the stem as effectually as could be done by the knife; or, even worse, because the wound is poisoned and the wood attacked after the bark is gone.

Nor does the injury end there. In heavy (adobe) soils the presence of a small amount of sal soda renders tillage almost impossible; in all cases it renders the production of good tilth more difficult, causing the formation of little close-textured pellets instead of true tilth. I will illustrate these points to you by experiment.

Here is a calcareous "adobe" soil wetted with pure water and dried.

I throw it on the floor before you, and it crumbles into a thousand crumbs. Here is a lump of the same soil wetted with sal soda solution, and also dried; I throw it on the floor and you hear it strike like a brick-bat, and it breaks into two or three hard clods, which you can just scratch with your finger nail.

You see the extreme importance of getting rid of the "black" part of alkali in every case. *This can be done by giving the soil a dressing of gypsum or land plaster.*

Here is a solution of sal soda; I pass it through this filter filled with black soil; you see the water that passes through is almost as black as ink, and we now have the same solution that you see in alkali puddles where it is "black." Had I time to finish this operation you would in the end find the black soil turned gray or whitish, just as are your alkali spots after the rain has washed out the color.

Now, I add to this black water a quantity of powdered gypsum, and shake it up. We shall have to wait a little to see the action completed; but in the end you will see that the solution has become nearly or quite colorless, while the gypsum has turned dark from the precipitated humus. That is precisely the way it acts in the soil; it keeps the humus from being washed away, and above all, it converts the "black" alkali into "white;" that is, the carbonate of soda has now been turned into sulphate of soda or Glauber's salt, which, as I first told you, is one of the chief ingredients of all our alkali, and is quite bland and harmless as compared with the corrosive sal soda. We have thus taken the cutting edge off the alkali.

In thousands of cases this change, with thorough tillage, is all that is needful to do away with all damage from alkali. The amount of plaster to be used per acre depends, of course, upon the strength of the salts in the soil. Sometimes five hundred pounds per acre will be enough, then again, it may take a ton, or even more, and after that perhaps an annual dose of from one to three hundred pounds per acre, until the carbonate of soda is completely destroyed.

You may ask how you are to know that by an easy test; here it is: This is paper tinted with a solution of litmus, a preparation you can find in most drug stores, and if not, they should be made to keep it for you; any acid (vinegar will do), you see, turns the blue solution red; add sal soda or potashes (ash lye) to the red solution, and the smallest amount will instantly turn it blue. So with this paper; as you see, I can change the color at will, and when the red paper turns blue when I touch the alkali water or the wetted soil, I know at once that there is black alkali there, even if it be too little to show in the mud puddles. Any child can make this test, but you must understand that the change to blue should be prompt. Almost any California soil will, in the long run, turn litmus paper blue, because all contain considerable lime, which acts like the sal soda, but much more slowly.

There is one virtue possessed by gypsum that I have not yet alluded to; it is, that when (as is frequently the case) the alkali contains phosphates in solution, these phosphates are fixed and retained in the soil; whereas, otherwise, every rain and every irrigation washes them out, more or less.

But if, after transforming your black alkali into white and practicing thorough tillage, you still find your trees or vines under stress, there is

but one remedy, a radical one, which rids you of all alkali, black and white, for good—*that remedy is* UNDERDRAINAGE.

That this is so is self-evident from the fact that in countries having heavy rainfall there is no alkali in the soils. What prevents it is the natural seepage through the soil into the country drainage. Where this does not exist naturally, it can be established artificially by first laying drain tiles and flooding the land until the last vestige of alkali is washed out. Experience fully and amply confirms this conclusion; but experience has also abundantly shown that alkali cannot be washed off the land by abundant flooding *without* drainage. All you do in that case is to put the salts down into the subsoil, from which they will rise again at the first chance, and your water and trouble will have been wasted. What you sometimes can effectively do, in bad cases, is to scrape off the alkali crust bodily and haul it off where it will be carried off by the streams—or possibly by the ditches—for the benefit of your neighbor below. Such things have happened.

But some will say, underdraining costs too much. About that I have only to say that I agree with you so long as you pay the railroad "all the traffic will bear" for freight on tiles. When you get to making your tiles right here, $85 per acre ought to pay for good underdraining in your porous soils. If there are those who think that also too much, let them cease to value their producing lands at $1,000 per acre, and sell out to progressive newcomers, who think otherwise.

It is true that the condition of things in your region is peculiar and different from most other localities in the State. Ten years ago no alkali was to be found within a long distance of Fresno City, but since that time leaky ditches have filled the country up with water from below, and that water has brought with it the soluble salts that had accumulated for ages in the forty or fifty feet of dry soil that then used to lie under your feet. As that water evaporates at the present surface, all that alkali must come to the top, unless carried off in some way, as by drainage.

I have lately, with the aid of two of your public-spirited citizens, Miss L. E. Hatch and Mr. John S. Dore, obtained the materials for a proper study of the actual state of things under your soil. They supplied me with samples of bottom water taken at various points, and by analyzing these and comparing them with the water of your ditches, we can see just how far the process of leaching upward is likely to supply your soils with alkali.

Partial Analyses of Some Bottom Waters of Fresno Region (grains per gallon).

	June, 1880.	Aug., 1889.	February, 1891.						
	No. 1. Kings River.	No. 2. I. F. Mouton, 4 miles S.W. of Fresno. 6 feet.	No. 3. Ball's Vineyard. 8 feet.	No. 4. Central Col'y Hedgerow Vineyard. 7½ feet.	No. 5. Central Colony, Lot 94. 7 feet.	No. 6. Jas. Hughes' Place. 8 feet.	No. 7. Washington Colony (Pond). 3 feet.	No. 8. Unused Well, 1 mile W. of West Park. 5 feet.	No. 9. J. S. Dore's Vineyard, West Park. 5½ feet.
Sodium and potassium sulphates (Glauber's salt, etc.)	.86	60.6	1.2	3.5	2.7	4.5	33.7	1.9	12.7
Sodium chloride (common salt)			1.0	.5	1.4	.5	24.5	1.4	.7
Sodium carbonate (sal soda)	.003	12.4	3.7	1.9	21.1	4.3	39.7	5.6	6.2
Calcium and magnesium carbonates, calcium phosphate, etc.	3.27	3.9	5.3	8.5	6.0	8.8	6.5	3.7	5.8
Silica		3.0	7.6	3.9	3.5	3.8	.3	2.5	2.3
Organic matter and chemically combined water		4.7	4.1	6.8	2.9	4.6	13.0	4.2	4.7
Totals	4.133	84.6	22.9	25.1	37.6	26.5	117.7	19.3	32.4

	73.0
	5.9
	2.
	9.3
	97.9
	8.9
	19.6

No. 7—In Detail.

Potassium sulphate	8.0
Sodium sulphate	25.7
Sodium nitrate	Traces.
Sodium chloride	24.5
Sodium carbonate	39.7
Calcium phosphate	.8
Calcium carbonate	4.2
Calcium sulphate	Traces.
Magnesium carbonate	1.5
Silica	.3
Organic matter	13.0
Total	117.7

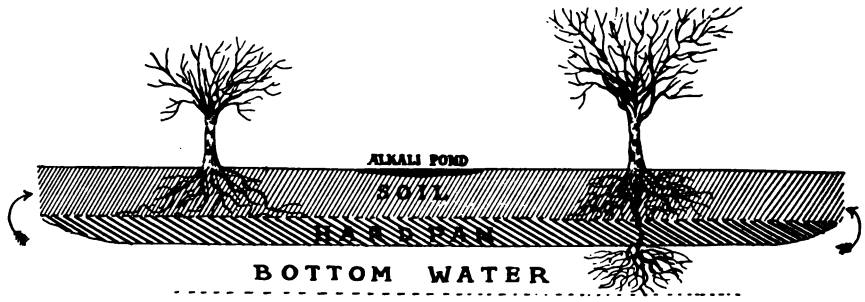
No. 2—Increase of Alkali from Bottom Water to Surface.

Depth.	Alkali in 100 Parts Soil.
Surface, 1 inch	0.76
18 inches	0.20
26 inches	0.18
42 inches (hardpan)	0.16
72 inches (bottom water)	*0.145

*84.6 grains per gallon.

Let me say from the outset that the results of this investigation (which I place before you) have been most encouraging. While it is true that there has been a serious increase of alkali over the Kings River water in all cases—say from seven to ten times, so far as the true alkali salts are concerned—yet the water, even thus, is not worse than a good deal that is used elsewhere for irrigation. There are two very bad cases, as you see, in which the alkali salts have increased from eighty to over a hundred times, forming dangerous waters. But these are taken from ready-formed alkali spots of an aggravated type; and for the existence of these there is a special cause to which you must pay the closest attention.

This cause is the existence, at various depths beneath the surface, of a layer of limy hardpan, which all of you have seen at some time. This hardpan is practically impervious to water, as it is to roots; your older residents know that they have many a time been obliged to "knock the bottom out" of a hole in which a tree or vine was to be planted, in order that the roots might be enabled to reach a proper depth. The sudden "going back" of plantations of trees and vines, that have been doing well the first two years, has almost invariably been traced to the existence of this hardpan, upon which the roots were compelled to spread out, or dry out, or be drowned out, according to circumstances. And *it is upon the areas underlaid by this hardpan that strong alkali has appeared in the Fresno region.*



At first sight this may seem difficult to understand, but the matter is really simple enough. In winter, when heavy rains prevail, or when the land is copiously irrigated, the bottom water rises and mixes with the irrigation water coming from above. Suppose this happens where there is a sheet of hardpan; then the mixed waters will rise around the edge of the sheet and spread over it. Now these sheets are usually basin shaped, ranging in outline from round to long-oval, and lowest in the center, with areas varying from a fraction of one acre to several acres. The water flowing in over the outer edge is retained there. It quickly evaporates from the shallow soil overlying the hardpan, and its alkali also remains and accumulates near the surface. Let this process be repeated for a few years, and several times each year, and soon the alkali accumulation will become sufficiently strong to affect the growing plants. After awhile the soil in the low center of the sheet becomes alkali-sodden, it loses tilth, and sinks down; then the alkali water gathers there, and we have formed an alkali pond like the one represented in the diagram, and by No. 7 of the table, with water too strong

for any useful vegetation. You see it is a bad case of "black" alkali, nearly one third of the whole solids of the water being sal soda. Even here gypsum would be useful, and should be used over the entire tract affected; but nothing short of drainage, or breaking up of the hardpan sheet, can work a radical cure.

The diagram also illustrates the difference in the development of the root-system of a tree, before and after the hardpan sheet is broken. The former will be suffering from both drought and alkali; the other will flourish.

It is not ordinarily, then, the alkaline bottom water, but the local sheets of hardpan that cause the scattered alkali spots of your region, and are the real cause of what trouble there is at present. You have not to fear a sudden general overrunning of your beautiful vineyards with alkali, so long as you keep the bottom water out of reach of the surface evaporation, and thoroughly till the soil. Yet certainly, the problem of general drainage is one that should receive your immediate attention, for your plantations are too valuable to be exposed to a gradual deterioration from neglect of leaky or leachy ditches. A good example of wise precaution in this regard has been given, for instance, by the seven-foot ditch that has been drawn around the property of the Fresno Vineyard Company; that vineyard will have no need to fear alkali or swamping.

A general system of drainage will, of course, involve some perplexing questions, not the least among which is the slight fall of the Fresno plateau in any one direction. Long main drains may be needed, and so long as these are not established, many will be perplexed as to where they can discharge the alkali water. Let me suggest that local relief may be found in draining into wells, the deeper the better. This would increase the alkalinity of the general bottom water for a time, but would give present relief to many.

My time and yours is too short to go further into the details of this drainage question, so I will conclude by summing up the measures of relief I have suggested:

First of all, wherever alkali appears, *look for the hardpan*, and if found break it up at as many points as possible, so as to allow the roots and water to penetrate beneath. Be careful of thorough tillage, and never allow a surface crust to remain after rain or irrigation. If the alkali is "black," use a proper dose of plaster to make it "white." Tighten ditches to prevent the rise of alkali water from below as much as possible, and seek to drain off the latter into the country drainage, whether by underdrains or, temporarily, by open ditches, laid deep enough to keep the water from being drawn to the surface by wick action.

Some—chiefly outsiders and newcomers—ask why we should bother with alkali soils at all, so long as there is so much good soil left that is not so tainted. The reply is, that alkali soils are, from their very nature, necessarily *rich* soils, and that the labor and expense bestowed upon their cultivation under proper conditions is sure to be richly repaid by the outcome. Such soils are largely without the need of fertilization, at least for a long time to come. Look even at the water of the "alkali pond" on the table, No. 7; there is among its ingredients no less than eight grains per gallon of potash sulphate, a most valuable fertilizer, the presence of which will almost forever relieve the cultivator from the necessity of purchasing it. The alkali of the spots at the Tulare station

would be worth about $7 per ton as a commercial fertilizer, and contains an abundance of almost every element of plant-food. It is the *excess* of useless salts that we must do away with; but we should carefully preserve and appreciate the good things nature has so abundantly supplied to our alkali soils.

ANALYSES OF ALKALI.

Alkali from soils on the farm of Sol. Runyon, near the Sacramento River, twenty miles below Sacramento; sent by N. W. Motheral, Entomologist of the State Board of Horticulture.

"*No. 1* was taken from the surface, at the root of a dying tree. *No. 2* was taken from under the tree, thirty inches from the surface, after the tree was dug up. Is there anything in the soil that would kill the tree?"

The result of the examination was as follows:

Soil No. 1.—The soluble salts in one hundred parts of the soil amount to .124 parts, and consist chiefly of carbonate of soda, with a small amount of common salt and Glauber's salt.

Soil No. 2.—The soluble salts in one hundred parts of the soil amount to .14 parts, and consist chiefly of carbonate of soda, with a considerable quantity of common salt and a trace of Glauber's salt.

The amounts of alkali salts in this soil and subsoil, as shown by analysis, are not sufficient to account for serious damage to the trees, *unless permitted to accumulate on the surface by evaporation*, by neglect of deep tillage. The quality of the alkali salts is quite corrosive, and, in any case, it would be best to correct this by the use of gypsum, transforming the "black" alkali into "white," or neutral salts.

Alkali from soils near Fresno; sent by Mr. J. S. Dore, Fresno.

"*No. 1* was taken from the top crust under some dead apricot trees. *No. 2* from the same soil, but eight inches below the surface. The calcareous hardpan is here just four feet below the surface. This place, some ten acres in extent, has never been irrigated; it is, however, subirrigated, and the ground-water is probably nine feet below. Grapevines and fruit trees are greatly injured by these salts."

No. 1 is a silty soil with a small amount of clay, and a large number of mica scales intermixed. A water extract gave a very faint alkaline reaction and contained 6.3 per cent of salts. Of the latter, a small proportion was insoluble in water, and consisted mainly of carbonate of magnesia with a small amount of sulphate of lime, or gypsum. The part soluble in water consists mainly of sulphate of soda (and some potash), common salt, and a little sulphate of magnesia.

No. 2. This is a light yellowish sandy soil, containing many mica scales. A water extract gave .19 per cent of soluble salts, which consist largely of common salt and Glauber's salt, with considerable sulphate of potash and slight amounts of lime and magnesia.

The character of the above salts is that of "white," or neutral alkali salts, and but for the existence of the hardpan beneath would hardly be fatal to apricot trees or vines. The hardpan, however, has doubtless caused them to accumulate to such extent that, in connection with water stagnating on it in winter, the joint effect has been hurtful. The breaking up or underdraining of the hardpan, together with deep and thorough tillage at all times, would be the proper means of reclamation.

No. 2 is but lightly charged, and with thorough tillage should not experience serious trouble from the neutral alkali salts indicated by the analysis, especially if not underlaid by hardpan.

Alkali from Pleasant Valley; sent by Mrs. M. E. Cleary, Coalinga, Fresno County. A whitish powder, accumulating by the evaporation of the waters of the streams of the valley.

The sample consists chiefly of sulphate of soda, or Glauber's salt, with small amounts of carbonate of soda (sal soda) and common salt. The waters of the streams (as is shown elsewhere) contain 119 grains per gallon of this salt, and are thus rendered unfit for domestic use.

Alkali from soil No. 1223 taken at various depths, on Sec. 3, T. 26, R. 23 E., Kern County; sent by Mr. John S. Hittell, San Francisco. It consists mainly of Glauber's salt with some common salt; no carbonate of soda.

	Depth 2 to 4 Feet.	Depth 10 Feet.
Total soluble salts in 100 parts of soil	.71	.34
Sodium chloride in 100 parts of soil	.18	.12
Sodium chloride in 100 parts of soluble extract	25.13	36.12

This, again, is neutral "white" alkali, of which only a large amount, accumulated at the surface, will injure trees or vines. This kind of alkali seems to be almost universally prevalent, where any at all exists, in the region southeast from Tulare Lake, in Kern County; doubtless owing to the fact, shown in other samples received from the same region, that crystals of gypsum are found imbedded in the subsoil at various depths, and thus prevent the formation of "black" alkali altogether. It is an excellent demonstration of the efficiency of gypsum in this respect.

Alkali from Kern Island; sent by Mr. Willis Carter, Bakersfield, Kern County. A surface crust heavily charged with soluble salts, from the effects of surface evaporation.

	In 100 Parts of Alkali.
Potassium sulphate	9.52
Sodium sulphate (Glauber's salt)	82.96
Sodium chloride (common salt)	.48
Sodium carbonate (sal soda)	.40
Magnesium sulphate (Epsom salt)	.50
Magnesium carbonate	.13
Calcium phosphate	.20
Calcium sulphate (gypsum)	.10
Oxide of iron and alumina	.30
Silica	1.34
Organic matter and chemically combined water	4.07
Total	100.00

This sample is thus seen to consist almost entirely of the sulphates of soda and potash, chiefly the former. There is not a sufficient amount of carbonate of soda to render the salts injurious to the soil, under proper conditions of subsoil and tillage. The percentage of potash is so large that the salt might be utilized as a fertilizer upon

lands deficient in that element of plant-food. The presence of phosphates also adds to the value of the salts as a direct fertilizer.

Alkali (two samples) from the Kern County artesian belt; sent by Mr. Geo. A. Raymond, San Francisco.

One of the samples consists almost entirely of Glauber's salt; it contains no carbonate of soda, and only a very small quantity of sodium chloride, or common salt. It is, therefore, of a mild type, and being readily soluble in water, can, by proper drainage, be easily removed from the soil if found to cause damage.

The other sample is in the form of small grayish lumps, and also consists mainly of sulphate of soda, a small amount of chloride of sodium, or common salt, being also present. It is of the same mild, or "white," type as the first, and, with good cultivation, should cause no serious injury.

Alkali, extracted from a soil, from Sec. 3, T. 31 S., R. 27 E., near Bakersfield, Kern County; sent by Mr. S. W. Austin, San José. The composition of the extract is as follows:

	Soluble Salts in 100 Parts of Soil.	Composition in 100 Parts of Alkali.
Sodium sulphate (Glauber's salt) } Sodium chloride (common salt) }	.215	97.73
Sodium carbonate (sal soda)	.005	2.27
Totals	.220	100.00

The presence of so small an amount of carbonate of soda does not materially injure the soil, and the other salts may not injure vegetation—especially trees or vines—so long as they are not allowed to accumulate at the surface, which can, of course, be prevented by deep and thorough tillage.

Alkali crust from Colton Avenue, near Hunt's Lane, Santa Ana bottom, San Bernardino County; top crust of the soil.

The alkali amounts to 9.593 per cent of the crust, and consists of—

Organic matter and water	4.358
Soluble in water	93.928
Insoluble in water	1.666
Silica	.048
	100.000
The soluble portion of the alkali consists of—	
Sulphate of potash	4.988
Sulphate of soda (Glauber's salt)	62.753
Sulphate of magnesia (Epsom salt)	.561
Carbonate of soda (sal soda)	14.886
Chloride of sodium (common salt)	10.770
	93.928
The insoluble portion of the alkali consists of—	
Sulphate of lime (gypsum)	.145
Carbonate of lime	.465
Carbonate of magnesia	.649
Peroxide of iron (as carbonate of iron)	.407
Total	1.666

The amounts of soluble sulphates and of common salt in the above crust are extremely large, and of course destructive to vegetation, but being easily soluble in water they can be readily removed by proper

drainage. But the presence of so large an amount of carbonate of soda (nearly 15 per cent of the salt, or 1.4 parts per hundred of the soil) makes the matter a far more serious one, especially when it is remembered that a percentage of less than one tenth of one per cent is sufficient to injure vegetation, by rendering the soil caustic and corrosive, and by dissolving out the humus. The only antidote would be a large application of gypsum and the thorough drainage of the land.

Alkali from the soil of a vineyard in El Cajon, San Diego County; sent by C. M. Johnson, M.D., San Diego.

"This land has been planted in vines for five years. In the locality from which the sample No. 1 was taken the vines have all been killed, and the surface has an efflorescent, ashy appearance. Sample No. 2 was taken from an adobe soil, but little distant from the first, and on which were vines of the same age. On both of these localities there is a slight depression, and back of them is a range of foothills three hundred feet in height, whose soil is springy, giving good sub-irrigation with a water that is sweet and not at all alkaline. Olives seem to do well, and quinces are growing luxuriantly in the strongest alkaline spots."

The samples sent are understood to represent the surface crust, say to the depth of one inch. Sample No. 3 is the subsoil of the above soils.

In 100 Parts of the Soil.	Soil No. 1.	Soil No. 2.	Subsoil No. 3.
Carbonate of soda	.662	.027	.050
Other soluble salts	3.433	18.823	.482
Total alkali	4.095	18.850	.532

The chief ingredient in each of the above is sodium chloride (common salt), with large amounts of sodium sulphate (Glauber's salt). With the amount of carbonate of soda shown in No 1, these constitute a pretty bad case of "black alkali." It is therefore one of the cases in which the use of gypsum (land plaster) is indicated, and in unstinted quantity, probably not less than five hundred pounds per acre for the first dressing. Soil No. 2 is heavily charged with "white alkali," and will therefore be little benefited by gypsum. With good tillage these neutral salts might not harm the vines. The subsoil, while not very strongly charged, still shows enough to render measures for drainage advisable as soon as possible.

Deposit in boilers, obtained by boiling an earth with water; sent by P. P. Keough, Bishop, Inyo County. "Does it contain borax?"

The deposit is soluble in water, and consists chiefly of sulphates of potash and soda, the latter (Glauber's salt) predominating, considerable common salt, and a very small amount of sulphate of magnesia (Epsom salt). Borax is present only in traces.

FURTHER EXPERIMENTS ON THE REACTIONS BETWEEN ALKALI SULPHATES, CALCIC CARBONATE, AND FREE CARBONIC ACID.*

By M. E. JAFFA.

[It will be remembered that at the meeting of this association held two years ago, I communicated a paper containing the results of a joint investigation by A. H. Weber and myself, on the formation of alkali carbonates from the sulphates, in presence of calcic carbonate and free carbonic acid. The wide importance of this reaction in nature, and practically in connection with the question of "alkali" lands and their reclamation, rendered a further pursuit of the investigation desirable; but lack of time has prevented its being carried to the extent contemplated, even in respect to the calcic carbonate alone, and only under ordinary conditions of temperature and pressure. Still, the results thus far obtained by Mr. Jaffa are of sufficient importance to render their communication at this time of interest.

The conditions under which Weber's experiments were made are given in the following quotation from the paper above referred to:

"The bulk of solution used was, in all cases, one liter; in this, precipitated calcic carbonate was kept in suspension by constant agitation, while carbonic gas was being passed into it at a temperature of about 18 degrees C., usually for forty minutes. The first effect was always a slight reddening of the litmus, due to the carbonic acid; but generally this reaction changed to alkaline during the first ten minutes, becoming stronger as time progressed. But comparative experiments showed that nothing was gained in alkalinity by a longer passage of the gas than above indicated.†

"In each experiment 100 ccm. were decanted immediately after the clearing of the magma, and titrated for 'total alkalinity,' including the calcic carbonate remaining in solution. When an alkaline sulphate was employed, the undissolved carbonate was tested for sulphuric acid, which in all cases was found to be present.

"Another portion of the decanted solution was evaporated to dryness, and the residue weighed as a whole, after drying at 110 degrees C., afterward leached and the filtrate titrated for its alkalinity.

"Another portion was mixed with alcohol so as to carry its percentage to about 60 per cent. This caused a gelatinous precipitate, which, after twelve hours standing, condensed into easily recognizable crystals of gypsum and calcic carbonate. The filtrate from this deposit was also titrated for its alkalinity. The subjoining table summarizes these results:

* Read before the Society for the Promotion of Agricultural Science at the Indianapolis meeting, August 19, 1890. See Station Report on Waters, 1889, p. 51.

† Mr. Weber's record shows the following observations on this point:

Time.	10 min.	30 min.	60 min.	11 hrs.	12 hrs.
Alkalinity in ccm. normal standard sulphuric acid	7.30	8.25	8.60	9.00	9.00

Experiments with Potassic Sulphate.

Grams per Liter:	¼	½	1	2
Evaporation residue 110 degrees, per liter (grams)	.837	1.195	1.619	2.735
Residuary alkalinity in same (ccm. standard H_2SO_4)	.35	.50	.45	.75
Total alkalinity of decanted solution	9.95	14.10	12.25	14.10
Residuary alkalinity after precipitation with alcohol	2.875	5.75	9.70	12.90
Corresponding $HKCO_3$ (per cent of total possible)	100.	100.	83.6	55.6

"The table shows that up to one half gram per liter, and beyond to a point not yet ascertained, there is a complete decomposition of the potassic sulphate, resulting in the formation of gypsum and potassic bi-(hydro-) carbonate. In a solution containing a gram of the sulphate per liter, only 83.6 per cent of the total possible amount of the carbonate is formed, and in a solution of double that strength (two grams per liter) only 55.6 per cent. But up to that point, and evidently some distance beyond, the *absolute* amount of alkaline carbonate is still on the increase; its ultimate limit remains to be ascertained."

Following the lines pursued in the previous investigation, Mr. Jaffa has used essentially the same methods, and in part the same materials employed by Mr. Weber; more particularly in his first set of experiments, the same precipitated calcic carbonate. It will be noted that in Weber's table there is a striking discrepancy in the "total alkalinity" for the operation with five grams per liter; this discrepancy disappeared upon a repetition of the determination by Jaffa, which gave 10.15 in place of 14.10 of Weber's table, and thus brings about a reasonable regularity of progression with increasing density of the original solution.—E. W. H.]

Table No. 1 summarizes the first series of my work, in which the intention was to complete the data given in Weber's table upon potassic sulphate. Adopting the first two columns, relating to solutions of .25 and .50 grams per liter (except that the "total alkalinity" was redetermined, as above stated), all the other determinations are my own, and, as will be seen, they differ not immaterially from those of Weber's table, being higher throughout. The most striking difference is, that whereas Weber found the critical point from which the decomposition of the potassic sulphate ceases to be complete, to lie between .5 and 1.0 gram per liter, I find it to be just beyond 1.0 gram; and I find a higher percentage of decomposition with 1.25 than Weber did with 1.0 gram (90.85 per cent against Weber's 83.6 per cent of the possible amount). The cause of these discrepancies is, doubtless, to be sought for in use of different materials and in slightly different external conditions, as noted in Table No. 1.

Having exhausted the supply of the calcic carbonate used by Weber, I prepared another batch, this time by precipitation with ammonium carbonate at the ordinary temperature instead of hot, as was done by Weber; the precipitate being thus, of course, finer and more bulky, and keing kept in suspension more easily. But, at the same time, the solution required to be filtered from the precipitate of gypsum and unaltered carbonate, instead of being decanted, as was done by Weber. As the filtration of 100 ccm. lasted less than one minute, the loss of CO_2 was too slight to cause the precipitation of calcic carbonate, for usually no scum formed on the surface of the covered solution for twelve hours.

Table No. 2 shows the results obtained with this new preparation of calcic carbonate.

It will be seen, on comparing Tables Nos. 1 and 2, that there is a wide discrepancy between the figures obtained with the first and coarser-grained calcic carbonate, and the fine powder of recent preparation. While in the first case the range between .25 and 4 grams per liter is 9.95* and 14.80, respectively, for total alkalinity, in the second case the range between the same limits is from 17.76 to 23.70. The "residuary alkalinity," after precipitation with alcohol (*i. e.*, that indicating the amount of alkali carbonate formed), is, of course, the same *within the limits of complete decomposition*, in both series; and the determination lying just beyond (for 1.25 grams per liter) shows practically identical figures (13.06 and 13.10). But beyond that point there is a rapid increase, which is particularly noteworthy in the figures showing the *actual amounts* of bicarbonate formed. Thus we find that in the 4-gram solution, 1.42 grams of the latter salt was formed when the coarse preparation was used, while 2.32 grams resulted under the influence of the fine precipitate of calcic carbonate, under identical conditions as to temperature and time. Moreover, in both series the progressive *increase* of the amount transformed became very slow with the 4-gram solution; the difference between the amount corresponding to 4 and 8 grams, being (in the second series) only .15, while between the solutions containing, respectively, 1.50 and 1.75 grams, the difference (for only a *fourth of a gram*) is .24. It would thus seem that, *under ordinary conditions of temperature and pressure*, the practical limit of action is nearly reached with a 4-gram solution.

The influence of *temperature* is rendered very apparent by the inspection of the entries showing the "residuary alkalinity" after evaporation at 100 degrees C. The ratio between the carbonates formed at ordinary temperatures, and those remaining after evaporation, is seen to be approximately one twelfth in the case of the first series, and about one seventh in that of the second; the difference being, no doubt, due to the difference of temperatures employed in drying the residues, *i. e.*, 100 degrees C. and 105 degrees C. as against 110 degrees C. used by Weber; but the law for intermediate ones remains to be determined.

It is of course to be expected that evaporation at ordinary temperatures, such as usually occurs in nature, will yield results approximating much more nearly to those indicated by the titrations.

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* It should be understood that in all cases, alkalinities expressed are in ccm. of normal standard H_2SO_4.

TABLE No. 1.—*Experiments with Potassic Sulphate and Coarse-Grained Calcic Carbonate.*

Grams per Liter:	.25†	.50†	.75	.875	.9375	1.00	1.25	1.50	1.75	2.00	4.00
Total alkalinity*	9.95	10.15	10.80	13.25	14.10	14.20	14.30	14.48	14.54	14.60	14.80
Residuary alkalinity* after precipitation with alcohol	2.875	5.75	8.63	10.07	10.78	11.50	13.06	13.60	13.84	14.10	14.20
Corresponding $HKCO_3$ (per cent of total possible)	100.00	100.00	100.00	100.00	100.00	100.00	90.85	78.84	68.75	61.30	30.87
Amount $HKCO_3$ formed (grams per liter)	.287	.575	.863	1.01	1.08	1.15	1.31	1.36	1.38	1.41	1.42
Alkalinity corresponding to $CaCO_3$*	7.07	4.40	2.17	3.18	3.32	2.70	1.24	.88	.70	.50	.60
Evaporation residue 105° (grams per liter)	.837	1.195	1.314	1.492	1.625	1.743	1.908	2.175	2.452	2.747	4.725
Residuary alkalinity in same, grams $HKCO_3$ per liter	.035	.050	.070	.075	.080	.082	.084	.089	.092	.095	.120

TABLE No. 2.—*Experiments with Potassic Sulphate and Fine-Grained Calcic Carbonate.*

Grams per Liter:	.25	.50	.75	1.00	1.10	1.25	1.50	1.75	2.00	4.00	8.00
Total alkalinity* filtered solution	17.76	19.00	19.50	20.10	20.30	20.80	21.20	21.60	22.10	23.70	25.70
Residuary alkalinity* after precipitation with alcohol	2.875	5.75	8.63	11.50	11.80	13.10	15.00	17.40	17.80	23.20	24.70
Corresponding $HKCO_3$ (per cent of total possible)	100.00	100.00	100.00	100.00	93.28	91.12	86.90	86.43	77.39	50.43	26.85
Amount of $HKCO_3$ formed (grams per liter)	.287	.575	.863	1.15	1.18	1.31	1.50	1.74	1.78	2.32	2.47
Alkalinity corresponding to $CaCO_3$*	14.88	13.25	10.87	8.60	8.50	7.70	6.20	4.20	4.30	1.50	1.00
Evaporation residue 100° (grams per liter)	1.177	1.450	1.750	2.026	2.128	2.300	2.600	2.774	3.090	5.170	9.308
Residuary alkalinity in same (grams per liter)	.060	.100	.120	.140	.160	.190	.200	.210	.239	.250	.260

TABLE No. 3.—*Experiments with Sodic Sulphate and Fine-Grained Calcic Carbonate.*

Grams per Liter:	.25	.50	.75	.80	1.00	1.25	1.50	1.75	2.00	4.00	8.00
Total alkalinity* filtered solution	19.10	19.50	20.58	20.65	20.82	20.95	21.30	22.30	22.95	25.00	26.20
Residuary alkalinity* after precipitation with alcohol	3.521	7.05	10.57	10.60	12.58	15.60	18.04	18.60	19.30	24.10	25.20
Corresponding $NaHCO_3$ (per cent of total possible)	100.00	100.00	100.00	99.53	89.22	88.44	85.29	75.32	68.43	42.73	22.36
Amount $NaHCO_3$ formed (grams per liter)	.296	.592	.889	.890	1.057	1.290	1.515	1.562	1.621	2.024	2.117
Alkalinity corresponding to $CaCO_3$*	15.58	12.45	10.01	10.05	8.24	5.35	3.26	3.70	3.65	.90	1.00
Evaporation residue at 100° (grams per liter)	.924	1.190	1.785	1.840	2.052	2.307	2.571	2.880	3.140	5.276	9.332
Residuary alkalinity in same (grams per liter)	.035	.054	.084	.108	.113	.134	.168	.183	.223	.252	.259

*Cubic centimeters of normal standard H_2SO_4. †Data from Weber's previous work.

EXPERIMENTS WITH SODIC SULPHATE.

A series of determinations was made with sodic instead of potassic sulphate, in order to determine whether the reaction follows the same law as in the latter, and if so, whether atomic proportions are observed from the outset; that is, from the weakest solution to the strongest.

Table No. 3 shows the result of this series of experiments. The first thing that strikes the eye in these results is, that while there is a general agreement of the progression, the sodic salt reaches sooner the point where complete decomposition ceases; that point lying at .8 grams per liter, instead of above 1.0, as in the case of the potassic salt. It will be noted that these figures approach closely to the atomic ratio, which should be .84 for sodium.

Continuing the comparison we find that the amounts of carbonate formed continue slightly higher for the sodic than for the potassic salt, until we reach in both 1.5 grams per liter, when the curves representing the progression diverge quite suddenly, the potassic salt increasing rapidly until, at the 8-gram solution, we approximate closely to the atomic ratio, the figures being 2.47 of potassic salt against 2.12 of sodic. The exact ratio would be 2.52 to 2.12, and would doubtless be reached at about the 10-gram solution for potassic sulphate. It thus appears that not only is the sodic salt transformed to a slightly greater extent than the potassic in very dilute solutions, but an inspection of the figures for "residuary alkalinity" after evaporation shows that larger amounts of the sodic salt are decomposed by high temperatures, falling considerably above the atomic ratio. But at 1.5 grams the amounts remaining undecomposed are in *atomic* proportions, and thereafter the sodic salt remains the more stable, until at eight grams the *absolute* amounts are equal, and therefore the atomic ratio is exceeded, the sodic salt being .259, instead of .218, to .260 of the potassic salt. It is to be expected that this greater stability of the sodic salt will be increasingly shown at lower temperatures, thus favoring the formation of "black alkali" under natural conditions.

There remains to be considered, so far as the present series of experiments is concerned, the quantitative relations of the calcic carbonate dissolved by the carbonic acid. The amount calculated as being precipitated by the treatment with alcohol of 60 per cent, is given in the fifth entry of the tables. The first point to be noted is that in the experiments made with the coarser carbonate the amount dissolved was very much less than in the finer grained, although an excess sufficient to maintain the reaction was always present.

The question may be raised whether the reaction was not influenced by failing to supply carbonic acid until the same amount of calcic carbonate was dissolved in each case. Against this objection we have thus far only the experiments of Weber, given above, and the fact that a true atomic proportion is reached where the amounts of lime present are smaller, viz.: in the strongest alkali solutions. It is intended to investigate this point at once to a definite conclusion, and the whole subject will be pursued into its ramifications with respect to the influence of the presence of other bases, and the variations of physical conditions, as rapidly as time will permit.

In the preceding experiments the reaction between alkali sulphate, ready formed, calcic carbonate, and free carbonic acid, has formed the

subject of investigation
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V. FRUIT AND VEGETABLE PRODUCTS.

INVESTIGATION OF CALIFORNIA ORANGES AND LEMONS.

By G. E. COLBY and H. L. DYER.

(*Experiment Station Bulletin No. 93; June, 1891.*)

[A full investigation of the various fruits produced in California with respect to their proximate as well as ultimate composition has long been contemplated at this Station; but the fewness of the available workers and the heavy demands made upon them in other directions has until now restricted this somewhat laborious branch of research to occasional tests, such as have heretofore been published in respect to particular lots of fruit sent for examination. With the increased force now at hand it is proposed to investigate, as rapidly as may be, all the more important fruits produced on a commercial scale, so as to determine accurately the composition of the various kinds and varieties, both with regard to food value, and to the draught made by them upon the store of plant-food in the soils of the several regions. Since the latter vary very greatly in their nature, and therefore the replacement of the ingredients withdrawn by the crops will need to be made in accordance with the special requirements of each case in order not to "carry coal to Newcastle" at unnecessary expense, such investigations are of the most obvious practical importance; but at the same time they are extremely complex, and much time will be required to bring them to even a moderate degree of completeness. The work here discussed was entered upon in response to the constant demand of growers of citrus fruits for information as to the most appropriate fertilizers to be used by them. While it is far from complete, and will, of course, be continued and extended hereafter, it settles some of the immediately pressing questions. In the execution of the work, Assistant Colby had the benefit of the very efficient aid of Mr. Hubert Dyer, a graduate of the University, and post-graduate student in this department. Without such help we would have had to remain satisfied with a much smaller number of analyses, and a much narrower basis for conclusions.—E. W. HILGARD.]

The purpose of this work is to show comprehensively the proximate and ash composition of the leading varieties as grown in some of the principal citrus regions, and, inferentially, the influence exercised upon them by the prominent conditions of soil, climate, fertilizers, etc. The physical data (per cent of rind, pulp, juice, etc.) are of special interest from a commercial standpoint, as showing what is being purchased; for there can be no hesitation between an orange or lemon of average rind, pulp, and juice, and one of over one third its weight of undesirable rind and one quarter dry pulp.

The consumer, though usually considering fruit as a pure luxury, would derive much valuable knowledge from studying the orange in its relative value as a food. The nourishing portions, shown specially by

the nitrogenous and saccharine contents, vary greatly with the variety and conditions of growth. It is not a matter of indifference to the consumer what fruit he uses, but an important question of domestic economy.

The ash ingredients, together with the nitrogen contents of the standard varieties, are of high interest in connection with the vital question of soil-exhaustion and fertilization. The soil ingredients extracted by an ordinary crop are a serious drain upon the supporting soil, and the lines of heaviest draught can only be determined by analytic determination of the constituents withdrawn.

Description of Oranges Received.

NAVELS.

No. 1. *Marysville, Yuba County.*—G. W. Hutchins, grower; sample received January 22d. A large, fairly solid, and heavy fruit, with rough thick skin, indented ribs, and loose "rag;"* juice only fair in amount, with pronounced acid, and good flavor.

No. 2. *Niles, Alameda County.*—Australian (?) Navel; J. Shinn, grower; sample received March 30th. Undersized, rounded in shape, thick, loose skin and "rag," with tender pulp and pleasant acid.

No. 3. *Niles, Alameda County.*—Australian (?); J. Shinn, grower; sample received May 19th. Fruit differed in shape, being both rounded and elongated; base ribbed; both skin and flesh remarkably tender, "rag" thick, only moderately juicy, but of very agreeable flavor. Both Australian (?) Navels were budded for Washington Navel by Mr. Shinn, who thinks, however, that the graft was taken from a sample tree of the Australian Navel.

No. 4. *Riverside, San Bernardino County.*—"Washington Navel;" from a box shipped to Professor Hilgard by Dr. Jarvis; grower unknown; received January 22d. It agrees well with a description of typical Navel, as given in Wickson's "California Fruits," page 451.

No. 5. *Riverside.*—R. W. Meacham, grower; received May 12th. This orange was selected by a prominent nurseryman of Riverside, in response to a request from this Station. A large, thick-skinned orange with heavy "rag" and coarse pulp, much more elongated than the typical Riverside Navel; some with base markedly depressed or crater-shaped, others flattened; acid, medium.

No. 6. *Pomona, Los Angeles County.*—Palmer & Shaw, growers; received April 10th; from trees six years old, on hill-land north of Pomona. An average-sized fruit, high in color, but with thick skin, heavy "rag," and broadened fleshy base. On the whole a very desirable orange.

No. 7. *Pomona.*—Selected by Short & Schwab, of Pomona, from a week's shipment, as "over-size;" received April 10th; from young trees (five years) bearing only five or six oranges. Double the usual size, and of correspondingly coarse structure, although not unpleasant to the taste; decidedly "watery" as compared with Nos. 6 and 8.

No. 8. *Pomona.*—L. M. Davenport, grower; sample received April 10th. An average-sized and thick-skinned fruit, of rather tender pulp and agreeable acid.

* "Rag" is the white tissue between the pulp and skin proper.

MEDITERRANEAN SWEET.

Nos. 9 and 10. *Smartsville, Yuba County.*—Seedling, resembling Mediterranean Sweet; Jas. O'Brien, grower; sample received January 22d. Above the medium size, light-colored and smooth skin, and very sharp; sample apparently not quite ripe.

No. 11. *Riverside.*—R. W. Meacham, grower; received May 12th. Somewhat elongated; color yellowish red; skin thick and with sooty pits; very juicy; pulp tender.

No. 12. *Pomona.*—J. D. H. Brown, sender; received May 5th. Rounder in shape, smooth and rather thick skin; "rag" coarse; very juicy and slightly tart.

ST. MICHAELS.

No. 13. *Marysville, Yuba County.*—G. W. Hutchins, grower; sample arrived January 22d. Undersized as compared with those from Pomona and Riverside; medium heavy "rag" and rind; solid texture, but pulp melting, and acid high.

No. 14. *Riverside.*—R. W. Meacham, grower; sample received May 12th. Larger than the Pomona fruit but of the same general appearance, save that the skin is lighter colored; also of rather flatter taste, but very juicy.

No. 15. *Pomona.*—Exhibit at Los Angeles Citrus Fair; sample received April 10th. A larger and less compact orange than that from Marysville; of very thin skin and tender pulp; acid very pleasant.

No. 16. *Pomona.*—"Paper Rind;" from J. D. H. Brown; received May 5th. Round shape, smooth thick skin, and very good flavor.

No. 17. *Pomona.*—From J. D. H. Brown; received May 5th. Considerably larger than No. 16; skin thick, of elongated shape and agreeable taste.

MALTA BLOOD.

No. 18. *Pomona.*—Mr. Reeves, grower; sample received April 10th. Rather larger and more round than the typical specimen; skin moderately thick; pulp tender; seeds none; acid remarkably sharp; juice light-red color and of considerable quantity.

No. 19. *Pomona.*—J. D. H. Brown, sender; received May 5th. It agrees in size and shape with the previous sample, but has a thinner skin and "rag;" acid less pronounced; pulp melting.

No. 20. *Riverside.*—R. W. Meacham, grower; received May 12th. More elongated than those from Pomona, and of rougher and thicker skin; base heavy; "rag" porous; pulp not quite so juicy, but of deeper red color; somewhat "mushy," indicating overripeness.

VALENCIA.

No. 21. *Pomona.*—Sent by J. D. H. Brown, and received May 5th. This is known in South California as "Valencia Late," or "Rivers," or "Rivers' Late." According to H. Van Deman, it is identical with "Hart's Late" in Florida. He is of the opinion that properly the name should be "Nonpareil." It is about the same in size as the Mediterranean Sweet, but much larger than the St. Michaels, and of marked elliptical form; smooth thin rind, "rag" of fine texture, pulp melting.

TANGERINE.

No. 22. *San Gabriel, Los Angeles County.*—A. B. Chapman, grower; sample received April 11th. A small deep-colored fruit with loose thick skin and fibrous texture of pulp; taste very sweet; acid low; flavor peculiar (like garden balm), but agreeable.

SEEDLINGS.

No. 23. *Niles.*—J. Shinn, grower; samples received May 19th. A large round orange of light yellow color; base ribbed and fleshy; heavy, leathery skin; thick "rag," melting pulp, and exceedingly pleasant flavor. General appearance marred by coast scale and fungus.

Description of Lemons Received.

EUREKA.

Nos. 24 and 25. *Pomona and Ontario.*—Two samples sent by Messrs. Short & Schwab, Pomona, April 10th. Of medium size, and with light seeds; juice rather bitterish.

No. 26. *San Gabriel.*—A. B. Chapman, grower; sample received April 11th. Undersized; some markedly ribbed, and with very thick skin; seeds small and undeveloped; flavor more agreeable than in the preceding Eurekas.

ARROYO GRANDE PRIDE.

No. 27. *Arroyo Grande, San Luis Obispo County.*—D. F. Newsom, grower; sample received April 22d. Undersized; smooth, heavy skin; bitterish to taste.

The accompanying tables show the analytical work accomplished for this season (1891). Table A gives the physical and proximate analyses; Table B, the results of the analysis of the ash.

In order to bring out more clearly than is shown by the tables the prominent points of similarity or difference, we discuss briefly the data presented.

ORANGES.

Proportion of Rind to Flesh.—Considering the matter, first, from the standpoint of the consumer, it seems that although the Navel is the largest of oranges, it has, contrary to the popular impression, no advantage, with respect to the proportion of skin to flesh, over either the Mediterranean Sweet or St. Michaels. The average Navel can fairly be considered as containing nearly 72 per cent of flesh, while the average Mediterranean Sweet shows 73 per cent; the St. Michaels, 81 per cent.

Juiciness, or Proportion of Juice to Flesh.—A comparison of the figures in the large table shows that of the named-varieties examined the Navel is the driest, while the St. Michaels has the largest proportion of juice, the Mediterranean Sweet being next, and the Malta Blood third.

These facts will be better understood by reference to the little table below, which gives the percentage ratios:

Average Percentage Ratios.

Variety.	Proportion of Rind to Flesh.		Proportion of Pulp to Juice in Flesh.	
	Rind.	Flesh.	Pulp.	Juice.
Navel	28.4	71.6	39	6
Mediterranean Sweet	27.0	73.0	33	6
St. Michaels	19.0	81.0	31	6
Malta Blood	31.0	69.0	36	6

Evidently the hard and solid, although thin rind of the Navel weighs heavier in the balance than the more "corky" one of the Mediterranean Sweet, and doubtless outweighs, also, that of many seedlings. The Navel, No. 4, from Riverside, the Mediterranean Sweet, and No. 8, from Pomona, however, show the lowest rind-percentage of any in the series, save St. Michaels, No. 15, of Pomona, the genuine "paper rind." The study of the conditions contributing to thinness of rind will be of high commercial importance.

Sugar Contents of the Juice.—The table shows the maximum of sugar in the hill-grown Navel from Pomona (No. 6), but this is approached very closely by Navel No. 8 of Pomona, the Mediterranean Sweet, No. 9, of Smartsville, the Malta Blood, Nos. 18 and 19, from Pomona, and the Tangerine from San Gabriel, No. 22. It is notable that the latter shows at the same time the highest proportion of cane sugar to be found in the whole series, the Pomona Navels and Malta Bloods standing next. To what extent the proportion of *cane* sugar determines the sweetness to the taste is a matter not yet fully understood; the proportion between the other two sugars (grape and fruit), not yet determined, being an essential factor in the case.

The average sugar contents of the fully ripe Navels (gathered in April and May), from all localities, is 10.8 per cent. Against this we find the Mediterranean Sweets from Riverside and Pomona (Nos. 11 and 12, gathered in May) to average 9.70 per cent only; while the seedling from Smartsville, gathered in January, shows a little over 10 per cent, thus indicating a very early maturity.

The Valencia orange, from Pomona (No. 21), shows a decidedly lower sugar-percentage, as does the contemporaneous Malta Blood, from Riverside. The St. Michaels shows the lowest average of all the oranges (8.71 per cent), although the roundish sample from Pomona (No. 16) falls only a little below 10 per cent.

Comparing these data with those of previous years, heretofore published, we find that the sugar-percentage of the Navel appears to have risen from 9.89 per cent to 10.80 per cent. For the Mediterranean Sweet the figure remains practically identical. For the St. Michaels it is higher than we have found it this season.

Acid in the Juice.—In respect to acid, we note at once the maximum in Malta Blood, of over 2 per cent, with an average of 1.6 per cent in the three samples examined. The next highest figures occur in the early samples of Mediterranean Sweet, from Smartsville, a maximum of 1.68 per cent; but the average of the many samples from Riverside and Pomona is 1.23 per cent. The St. Michaels of Marysville (January twenty-second) shows the next highest maximum with 1.46 per cent,

but in the later samples of April and May we find in the Riverside sample (No. 14) a minimum of .84 per cent, with an average of 1.07 for the four later samples examined. In contrast to the Malta Blood, therefore, the St. Michaels counts among the varieties of low acid, combined, however, with rather a low sugar-percentage, as stated above.

The Valencia rates, in the same respect, nearly with the St. Michaels, while the Tangerine shows the low figure of .87 per cent of acid, with, at the same time, a very high sugar-percentage. A former analysis showed for its close relative, the Mandarin, a lower minimum of acid (.36 per cent), and the highest sugar-percentage on record, or 13.84 per cent.

The Navel justifies the statement made in a former report, of the low acid-percentage, even in samples gathered as early as January (Nos. 1 and 4), and still more in those of later date from Riverside and Pomona (Nos. 5 and 6). The minimum (.77 per cent) of all is shown by the Pomona fruit (No. 6), with, at the same time, the highest sugar-percentage (11.20) of the series. In the aggregate, the average acid-percentage of the Navel (1.02) is the lowest of all, with the highest average of sugar (9.92 per cent) outside of the Malta Blood. These data, together with its firm flesh, thin and smooth rind, and excellent keeping qualities, explain sufficiently the great preference given it in our markets.

Comparing these results, obtained in 1891, with those in previous publications of this Station, 1879–1887, we note, first, an apparent increase in the average weight of the several varieties. We also find that while the percentages of rind show very nearly the same average as in 1891, there is a marked discrepancy in respect to juiciness, the pressed pulp averaging about 25 per cent less in earlier specimens. How far these differences may be due to influences of season or accident in sampling, is difficult to decide with the data before us; the more so, as the acid and sugar percentages show very nearly the same absolute, as well as relative, figures. Increased age of the bearing trees may possibly account for some of these differences.

The Pomona Navel from young trees (No. 7) is interesting, as showing just how an abnormally large orange differs from the ordinary fruit. It is markedly "watery" as compared with fruit of normal size.

The Mediterranean Sweet (Nos. 9 and 10) are of special interest, since they show the changes produced in an orange by two months' storage; there is a considerable loss in weight, which is found in the diminished weight of rind and flesh. Both the sugar and acid contents have increased, the former so appreciably as to warrant the conclusion that the fruit was sweetened by keeping, apart from evaporation. It was noted on receipt of No. 9 that the sample was not thoroughly ripe, and the taste of the same fruit two months later was decidedly better.

Nutritive Values—Nitrogen Contents.—The flesh-forming ingredients (albuminoids) of any article of food being of great importance as regards its proper uses, it is of special interest to compare, in this respect, the orange to other fruits, and the different varieties of oranges amongst themselves. According to the latest European data, oranges stand first in the amount of albuminoids (1.73 per cent), prunes second (.78 per cent), peaches (and probably apricots) third, bananas and grapes fourth, while apples and pears stand nearly the lowest on the list (.375 per cent). Our determinations of the same substances in California oranges, as a whole (rind included), show materially

smaller figures, averaging 1.20 per cent; and as it is known that the rind is very poor in these substances, we are forced to conclude that the California fruit is less nourishing than that of Sicilian production; much lower percentages, however, are quoted for oranges from other sources.

Here, again, the differences observed may be largely due to the age of the trees bearing the fruit, which in California is usually the minimum.

Of the entire series the Riverside Navels (Nos. 4 and 5) show the highest contents of albuminoids (1.54 per cent), while the average of the Pomona samples is 1.18 per cent only. Next highest to the Riverside Navels come the St. Michaels from Marysville, Riverside, and Pomona, with an average of 1.40 per cent; nearly the same is shown by the Riverside Malta Blood. The average of the Mediterranean Sweets falls below 1 per cent, that from Pomona falling to .91 per cent. The Malta Blood and Niles Seedling show the minimum of .69 and .75 per cent, respectively. The Valencia and Tangerine, with the Eureka lemon, seem to range about 1 per cent.

Amount and Composition of Ash.—The table below gives in detail the amount and composition of the ash of representative samples of the several varieties. It will be noted that the average ash-percentage in the oranges is only four fifths of that in the lemons; also, that the average orange is somewhat richer in potash and in phosphoric acid than the lemon, but the latter takes up materially more of lime and less of magnesia. Potash is the prominent ash-ingredient most heavily drawn upon from the soil.

TABLE B.

Analyses of the Ash of California Oranges and Lemons, 1891.

Number	Variety.	Place of Production.	Percentage of Pure Ash.	Composition of the Pure Ash.												
				Potash	Soda	Lime	Magnesia	Peroxide of Iron	Br. Oxide of Manganese	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine	Total	Less Excess of Oxygen, due to Chlorine	Total
	ORANGES.															
1	Navel	Marysville	.399	55.26	1.39	16.37	5.50	.41	.28	12.41	6.81	.55	1.04	100.02	.23	99.79
4	Navel	Riverside	.451	49.07	3.30	26.42	5.08	.42	.44	9.80	4.23	.79	.63	100.18	.13	100.05
6	Hill Navel	Pomona	.407	47.51	3.06	17.50	6.33	1.41	.24	14.15	7.91	.98	1.00	100.09	.22	99.87
9	Seedling like Med. Sweet.	Smartsville	.529	43.90	2.31	27.77	5.26	2.00	.18	13.10	4.34	.53	.59	99.98	.12	99.86
11	Mediterranean Sweet	Riverside	.413	51.25	2.41	18.78	4.76	.62	.32	14.46	5.58	.85	.92	99.95	.20	99.75
13	St. Michaels	Marysville	.477	47.60	4.09	24.70	6.36	1.18	.40	10.00	4.84	.38	.63	100.18	.18	100.00
15	St. Michaels	Pomona	.556	45.82	2.85	27.20	4.29	.97	.39	12.99	3.93	.31	1.37	100.13	.30	99.83
18	Malta Blood	Pomona	.454	52.20	1.48	19.07	4.75	.84	.64	14.71	4.29	1.06	.95	99.99	.20	99.79
22	Tangerine	San Gabriel	.461	47.87	1.67	26.65	5.48	.94	.45	9.75	5.36	.63	1.23	100.03	.27	99.76
	LEMONS.															
24	Eureka	Pomona	.632	45.32	2.03	34.07	4.00	.28	.28	10.19	2.74	.54	.51	99.96	.11	99.85
26	Eureka	San Gabriel	.535	51.20	1.50	25.67	4.80	.58	.28	12.00	2.94	.68	.27	99.92	.05	99.87
	AVERAGES OF ANALYSES.															
---	Oranges	----------	.432	48.94	2.50	22.71	5.34	.97	.37	12.37	5.25	.65	.92	-------	------	99.98
---	Lemons	----------	.526	48.26	1.76	29.87	4.40	.43	.28	11.09	2.84	.66	.39	-------	------	99.98

Draught upon the Soil Ingredients.—As will be seen by reference to Bulletin No. 88, of this Station, the orange stands *second* (grapes being first) among orchard fruits in the quantity of mineral matter withdrawn from the soil. Heretofore we have been obliged to base all conclusions bearing upon the ash and nitrogen of these fruits on European data; we are now enabled to present for oranges and lemons the outcome of California growth. The following summary (based on averages from the large table) shows, in tabular form, the amounts in pounds of the soil ingredients extracted by an orange or lemon crop that will have to be replaced by fertilization:

Ingredients Withdrawn from the Soil by Citrus Fruits.

	Total Ash—Pounds.	Potash—Pounds.	Phosphoric Acid—Pounds.	Nitrogen—Pounds.
ORANGES.				
European (seedless)—				
Crop of 1,000 pounds	6.07	2.78	.67	2.69
Crop of 20,000 pounds	121.40	55.60	13.40	53.80
California—				
Crop of 1,000 pounds	4.32	2.11	.53	1.83
Crop of 20,000 pounds	80.40	40.14	10.60	36.60
LEMONS.				
Crop of 1,000 pounds	5.57	2.69	.61	1.51
Crop of 20,000 pounds	111.40	53.80	12.20	30.20

It thus appears that so far as oranges are concerned, the California fruit draws materially less upon all the soil ingredients that have to be replaced by fertilization; while as regards the lemon, it approaches closely to the European standard for the orange, save in the much smaller draught upon nitrogen.

There is, of course, no material difference in the relative proportions of ash ingredients among themselves, or towards nitrogen.

Potash is seen to be the predominating ingredient, amounting to quite half of the weight of the ash; it is, therefore, highly important that the supply of this substance should be kept up; but fortunately, as has been shown by previous investigations of this Station, the supply of this substance in California soils and irrigation waters is exceptionally large, so that in many cases the current demand of the fruit will be amply supplied in the ordinary course of cultivation for many years to come.

Phosphoric acid is not very heavily drawn upon; but as it is usually present in our soils in limited quantities only, it is probable that it should constitute a large proportion of any fertilizer used in the orange orchard.

Of *nitrogen* nearly the same may be said as regards the natural supply, especially in the southern mesa soils; and as the draught made by the orange upon this substance is very heavy, it will always be among the first to be currently supplied.

As regards other ash ingredients, it will be seen that *lime* is the one most heavily drawn upon next to potash, although its percentage varies rather widely (from 16.37 to 27.77 per cent for oranges). The supply of lime in California soils is almost universally so ample within the

orange-growing region, that no replacement of this substance in fertilization will be called for.

The not inconsiderable demand of the orange for sulphuric acid, as seen in the table, suggests that gypsum will be acceptable in this as in other respects as a fertilizing ingredient.

LEMONS.

The incompleteness of the data concerning lemons renders it inadvisable to enter upon any extended discussion; the more so as no extended data from the Old World are available for comparison. It will be noted that the most important ingredient of this fruit, viz., the acid-percentage, considerably exceeds, for the Eureka lemon, at least, the commonly assumed average; and in the case of No. 26, from San Gabriel, the acid-percentage is extraordinary. This point alone should insure to California-grown lemons a high position in commerce.

The relatively large percentage of sugar shown by the analyses is a feature which will further commend them to the consumers' taste, as against the percentages usually reported. It will be observed, however, that very great differences exist in the proportion of rind to flesh and extractable juice. In this respect the lemons of Pomona and Ontario stand at the head of the list as far as it goes.

In ash composition there is no practically material difference between the oranges and lemons examined; with a more extended series the variations in both would doubtless be shown to run parallel.

ANALYSIS OF APRICOTS.

Small Early Apricot.—"Pringle?" The sample was received June 30, 1891, from Mr. B. F. Moore, Tulare.

The average weight was 24.8 grams, or 383 grains, eighteen being necessary to weigh a pound. The percentage of flesh was 90.9, the pits making the remaining 9.1 per cent. The juice was found, on analysis, by the copper (inversion) test, to contain 13.5 per cent of sugar.

The exceeding sweetness of this early fruit was so striking as to render its determination a matter of curiosity as well as of some general interest. The result—13½ per cent of sugars in the juice—is the highest but one (16.5 per cent) we can find on record for apricots, the usual average given being about 4.69 per cent in the whole fruit for European varieties. This latter figure, however, refers to fruits grown outside of California, and we have yet to learn what is the usual percentage of sugars in our standard canning and drying varieties of apricots.

A number of additional analyses of apricots are in progress at this date, and will be reported hereafter.

EXAMINATIONS OF SUGAR-BEETS.

The exceptional perfection attained by the sugar-beet in California, and the peculiar climatic advantages offered for the establishment of the beet-sugar industry, having now been fully recognized and action taken thereon by capitalists, it becomes unnecessary for this Station to repeat

hereafter what for eleven years past has formed "the burden of its song" in every report, although derided and systematically belittled by more than a few of the present enthusiastic converts. It now behooves more, perhaps, to preach caution against unwise efforts to establish the industry where it is not likely to prove successful, from the very fact that certain localities appear to enjoy such distinguished advantages of soil and climate that others, less favored, cannot reasonably hope to compete with them. It is therefore intended, not only to test the culture of the several varieties systematically at each of the culture stations, but also to distribute seed to those who desire to make private tests and to send the roots for assay to the station at Berkeley. The transmission of such samples for this purpose from all parts of the State is invited, in order that by the systematic comparison of results the greater or less adaptation of the several climatic divisions may be ascertained, as speedily as possible.

One of the most important points to be elicited by experiments is the season within which successive plantings of beets may be made, so as to prolong, as much as possible, the duration of the "campaign" of the factories. Personally, the Director does not as yet abandon the hope that in certain regions, at least, the *drying* of beets may be made feasible by proper appliances, thus extending the possible activity of the factory-plant through the whole year.

SUGAR-BEETS AT FRESNO.

(*Experiment Station Bulletin No. 73; August, 1887.*)

The culture of the sugar-beet in the San Joaquin Valley has, until lately, remained a bare suggestion. It is well known that they have been successfully grown near Isleton and Sacramento, on the moist lands of the Sacramento River, on which irrigation is unnecessary. It is doubtful that the sugar-beet has ever before been cultivated where irrigation is indispensable, and this fact, as well as the high summer temperature of the southern valley, has discouraged the attempt. In fact, the very idea of a root filled full of irrigation water, and then wilted by the torrid heat, is enough to excite the antipathy of the manufacturer.

The success of the sugar-beet near Los Angeles, however, encouraged the hope that, with a proper selection of soil, and of the time of planting and irrigation, a root suitable for the sugar-maker might be produced in the San Joaquin Valley; and if so, that the crop might be made to supplement that of the coast valleys, so as to prolong materially the annual campaign, the shortness of which is a heavy charge on the capital invested in the somewhat costly plant of beet-sugar factories. As stated in a paper on the subject, published in the December number of the "Overland Monthly," 1886, the campaign period in Europe usually does not much exceed three months—October, November, December—while in California, owing to the favoring climatic conditions, there is no difficulty in lengthening it to the five months, from September to January, both inclusive. If, by early sowing in the precocious season of the upper San Joaquin, two or three months more could be added to the time of campaign, it would place beet-sugar production in this State on a ground of vantage, from which it might calmly defy the competition of its tropical competitor, the sugar cane.

Preliminary experiments to test the feasibility of growing good sugar-

beets under the condition of the Fresno climate have, during the present season, been made by Mr. M. Denicke, of Fresno. Mr. Denicke obtained last autumn from Mr. Dyer, of Alvarado, some reliable sugar-beet seed, and sowed it at intervals from December to April. The results of the examination of four lots, planted and harvested as stated below, were as follows:

Lot No. 1.—Seed sown in December, harvested May twenty-seventh. The lot consisted of four roots, two of which (A) showed just an indication of new growth starting in the center, while in the two others (B) a short seed-stalk was already formed, so that they had evidently passed the proper stage for sugar-making.

Lot No. 2.—Two beets from seed planted early in April by Mr. L. J. McCleary, on sandy, ashy soil, on Kings River, six miles east from Selma. Harvested June twenty-sixth. Little or no indication of new growth starting.

Lot No. 3.—Two roots. Seed sown about March fifteenth, on "white-ash" soil. Harvested June twenty-ninth. Somewhat fresh-looking in the center, but no serious show of new growth.

Lot No. 4.—Date of sowing not stated. Roots in good apparent condition. Harvested August fourth.

The assays resulted as follows:

Assays of Fresno Sugar-Beets.

Lots.	Sown.	Harvested.	Average Weight, Ounces.	Cane Sugar, Per Cent.	Purity Coefficient.
No. 1 A	December	May 27	21	10.1	82.6
No. 1 B	December	May 27	24	7.0	70.0
No. 2	April 10?	June 26	18	10.5	80.7
No. 3	March 15?	June 29	22	12.6	82.0
No. 4	?	August 4	25	13.2	75.3

With regard to the data in this table, it should be stated for the benefit of the general reader that roots having an average of 10 per cent of cane sugar and a purity coefficient of 80 (that is, 80 per cent of cane sugar in the total solid contents of the juice), would be considered a fair workable material by the European sugar-maker. But a higher sugar per cent in the juice may offset a lower degree of purity, and *vice versa*.

It will be noted that the average of the first three lots (leaving out of consideration lot 1 B) is 11.1 per cent of sugar, with a purity coefficient of 81.4; they are, therefore, quite within the limits stipulated by the sugar-maker. As for lot 1 B, the fact that the roots had begun to throw out seed-stalks shows at once that they had passed beyond the limit within which the crop should have been harvested. I conjecture that this growth had been started by untimely irrigation. As for lot 4, although it shows a somewhat higher sugar-percentage than No. 3, its lower purity coefficient would nevertheless render it less desirable as it stands; but the appearance of the roots suggest, in this case, also, that the proper time for harvesting had passed by.

Considering that the persons growing these beets were without experience in the premises; that, in fact, irrigation had never before been applied to the production of sugar-beets, and that the right time and

the proper amount must in this case be considered as at least equally as important as in the case of wine grapes, the results obtained are exceedingly encouraging. They imply that in middle California the working campaign for sugar-beets can very probably be extended through the months of June, July, and August, making it reach from June first to February first; and considering that the beets of the first lot had already passed their best condition by a week or two, and that with somewhat improved arrangements for the preservation of the late-grown beets, they can probably be carried to the middle of February, we can foreshadow the possibility of such an extraordinary feat as an *eight months'* campaign of a beet-sugar factory running on fresh beets. With the additional possibility of utilizing beets sliced and dried, under the same conditions as the raisin crop, the full twelve months may ultimately be called into requisition.

It must, however, be remembered that in order to realize such results, it must be feasible to bring the beets of the San Joaquin Valley, and those of the coast valleys, within reach of one and the same factory plant. The roots will not bear railroad transportation to any distance; but with cheap water transportation it might be feasible to let the crops of Fresno and Merced start up the factories located in the upper bay region in June, and to keep them running until the middle of February by supplies from the coast region. It is to be hoped that more extended and carefully guarded experiments will be made the coming season, even if the omission of Congress to render the Experiment Station Bill effective by means of an appropriation should not be made good in time.

ANALYSES OF SUGAR-BEETS.

Sugar-beets, from eight miles north of Santa Rosa, Sonoma County, on the Calistoga road; sent by Mr. E. E. Sawyer, Santa Rosa, October 14, 1890. The seed, obtained from the University Experiment Station, was planted on May 17, 1890.

Sample *No. 1* was grown on sandy, alluvial soil, in the bed of the Mark West Creek. Its weight was 1,085 grams (2.3 pounds), and the specific gravity of the juice, 1.0766; the solid contents of the juice amounted to 18.50 per cent, of which 15.80 per cent was cane sugar and .80 per cent was ash. The purity coefficient was, therefore, 85.40 per cent; and this, with the high sugar content, places these beets far above the minimum required for profitable working. It is a first class beet in every way, and makes an excellent showing, especially for so large a root, which was a little above the weight generally admitted by the factories.

Sample *No. 2* was grown on an upland soil, which fairly represents the greater part of the land of the vicinity. The weight of the sample was 330 grams, and its specific gravity, 1.0434; the solid contents amounted to only 10.80 per cent, with a very small content of sugar, which places it far below par.

Sugar-beets from the Chino Ranch, San Bernardino County; sent by Mr. Richard Gird, Chino. They were grown upon a dark sandy loam soil, and from the Klein von Slavin seed, and were received in good condition July 16, 1890, nearly five months from planting.

Sample *No. 1*, comprising three beets; the seed was planted February 24, 1890, at a distance of four inches in rows fifteen inches apart. The

beets averaged 600 grams in weight, and yielded 280 ccm. of juice, with a specific gravity of 1.0875. The solid contents of the juice amounted to 21 per cent, of which 13.55 per cent was cane sugar. The purity coefficient was, however, only 64.50 per cent, or 10 per cent below that at which it is held that beets can be profitably worked; the percentage of "non-sugar" is too great.

Sample *No. 2*, comprising one beet, was from the same seed planted at distances of six inches in rows fifteen inches apart. The beet weighed 670 grams, and the amount of juice was 420 ccm., having a specific gravity of 1.0740. The solid contents of the juice were 17.90 per cent, of which 11.63 per cent was of cane sugar; the purity coefficient was, therefore, 65.00, which, with the small sugar content, places the beet far below the minimum of profitable working. It was probably immature.

Sugar-beets from Watsonville, Santa Cruz County; sent by Mr. N. D. Barry, Watsonville, October 16, 1891. The average weight of the two samples was 600 grams, or 1.3 pounds; the juice had a specific gravity of 1.0801; the solid contents were 19.3 per cent of the juice, of which 16.8 was cane sugar, and .60 per cent was ash. The purity coefficient is therefore 87.1 per cent, or 12 per cent higher than the minimum for profitable working. The content of cane sugar is also higher than usual, and nearly 5 per cent above the average richness of beets used in sugar manufacture in Europe. These samples are as fine as any thus far examined in the State, and it is unfortunate that the variety of seed, and the nature of the land, both physical and chemical, are not known.

Sugar-beets from the Foothill Station, five miles northeast of Jackson, Amador County. These samples, representing five different varieties, were grown upon the red slate soil (No. 1113) of the station tract, which in a previous report is thus described: An orange-red loam, the lumps of which are easily crushed between the fingers when dry, and show considerable coarse sand. When wetted it becomes only moderately adhesive, while its color darkens materially. Slate fragments are intermingled more or less all through, much of the sand being comminuted shale. The vegetation on this soil comprises yellow, sugar, and nut pine, the two mountain live oaks, black, white, and blue oaks, buckeye, buckthorn, toyon, manzanita, madrone, spiny chaparral, poison oak, or rather, sumac. Among the herbaceous growth the yerba santa, several bunch grasses, the alfilerilla, and several native clovers were conspicuous. The subsoil (No. 1114), from twelve to twenty-four inches in depth, is a loam of glaringly orange-red tint, the lumps of which, when dry, can hardly be crushed between the fingers. Its color hardly changes on wetting, but it becomes quite adhesive when kneaded; like the soil, it shows much coarse sand and some slate fragments. This material reaches here to depths of three to five feet, with increasing number of slate fragments.

The following analyses give the composition of the soil and subsoil:

Sugar-Beet Soil of the Foothill Station.

	No. 1113. Soil.		No. 1114. Subsoil.	
Coarse materials > 0.5mm	19.20		7.86	
Fine earth	80.80		92.14	
	100.00		100.00	
Analysis of Fine Earth.				
Insoluble matter	49.96	64.92	40.93	62.16
Soluble silica	11.96		21.23	
Potash (K_2O)	1.48		1.82	
Soda (Na_2O)	.43		.43	
Lime (CaO)	.60		1.37	
Magnesia (MgO)	2.21		2.28	
Br. ox. of manganese (Mn_3O_4)	.05		.05	
Peroxide of iron (Fe_2O_3)	11.52		11.89	
Alumina (Al_2O_3)	12.31		14.08	
Phosphoric acid (P_2O_5)	.05		.07	
Sulphuric acid (SO_3)	.02		.02	
Water and organic matter	6.63		5.62	
Totals	100.22		99.79	
Humus	.54		.18	
Ash	.80		.33	
Sol. phosphoric acid	.03		.01	
Silica	.60		.19	
Hygroscopic moisture (absorbed at 15° C.)	5.74		6.59	

The potash percentage in the above is very high; the amount of lime, though not very high in the surface soil, is abundant in the subsoil; direct determination shows .04 per cent to be in the form of carbonate. The percentage of phosphoric acid, as usual in California upland soils, is not high, but very largely in the soluble form. The amount of humus is rather low. For the special culture of the beet there is an ample supply of potash, lime, and phosphoric acid, but probably a deficiency of humus, the reservoir for nitrogen compounds so important for the thrifty growth of the plant; it having been found that "roots which bear leaves of a broad surface are generally more rich in sugar than those having small leaves upon a contracted top."

The five varieties of sugar-beets were sown May 6, 1890; the bottom leaves turned yellow September twenty-sixth; were harvested November third, and forwarded to Berkeley February 2, 1891.

Though sown on both the granite and red land, the samples forwarded were of the red soil only. Those on the granite soil were beaten down by the rain and covered with such a thick and impenetrable crust that the beds could not very well be reclaimed for that season; the few plants coming up were of no use. Those on the red soil received occasional irrigation from the seepage of the vegetable patch close by. They were also hoed three times; no manure of any kind was applied. The piece of land in which they were grown is considered the richest part of the red soil, but as it contained little or no sand, it is not very well fitted for cultures which must be hoed; the ground bakes and forms a troublesome crust, which cracks in the sun as soon as irrigation is given.

The samples were received on February 11, 1891, and analyzed on the next day, with the following results:

Analyses of Sugar-Beets from the Foothill Station, Amador County.

	No. 1. Bulteau Deprèz (Richest).	No. 2. Florimond Deprèz (Richest).	No. 3. Dippe's Kleinwanzlebener.	No. 4. Simon Le Grand White Imp.	No. 5. Dippe's Vilmorin.
Average weight of sample (grams)	320.0	371.7	380.0	326.6	385.0
Average amount of juice (ccm.)	186.6	183.3	208.3	183.3	210.0
Specific gravity of juice	1.0744	1.0687	1.0652	1.0713	1.0647
Solid contents of juice	18.00	16.70	15.90	17.30	15.80
Cane sugar, per cent of juice	14.13	12.79	12.82	12.96	13.38
Purity coefficient	78.50	76.60	80.63	74.90	84.64
Saline coefficient	16.05	14.50	19.13	21.20	17.3
Ash, per cent of juice	.88	.89	.67	.61	.77

All of the varieties are below the average weight, but all fall within the weights regarded at the factories as profitable for working, though varying greatly in sugar contents and purity coefficients.

The *Bulteau Deprèz* has the largest percentage of solid contents as well as of sugar, though its purity coefficient is low. The percentage of ash is somewhat greater than desirable, and militates against the working value of the sample.

The *Florimond Deprèz* would probably be rejected at the factories because of its low purity coefficient and rather high ash-percentage, though having a fair sugar content.

The *Dippe's Kleinwanzlebener* ranks very well with a good sugar content, a high purity coefficient, and a low ash-percentage.

The *Simon Le Grand White Improved* has in its juice a large amount of solid contents, which, though its sugar content is good, places the purity coefficient quite low and within the danger limit; its ash is fortunately low.

The *Dippe's Vilmorin* is, seemingly, the best of the varieties, with a good percentage of sugar, and a high purity coefficient, though its ash is dangerously high. It is questionable whether its value as a sugar-beet is above the Dippe's Kleinwanzleben, which has a lower purity coefficient, but at the same time a much lower ash-percentage.

Sugar-beets from the Southern Coast Range Station, two miles from Paso Robles, San Luis Obispo County. The seed was sown on May 5, 1890, and the crop harvested on October 6, 1890.

The five samples, representing as many different varieties, were grown on the sandy loam soil (front land soil No. 1147), which consists mainly of granitic sand, intermingled with white hornstone and claystone debris, most of which is little, if at all, waterworn. A small, but somewhat variable proportion of clay, serves as a binding material, which gives the soil enough consistency to turn a furrow slice, and to prevent leachiness. The tree growth consisted almost exclusively of the blue oak, with a few small white oaks. The soil is of a reddish-gray or fawn color, which deepens considerably on wetting, by bringing out the color of the humus present; but it can hardly be said to assume any plasticity, and could evidently be safely plowed almost at all times.

The composition of this soil, as reported previously, is as follows:

Sugar-Beet Soil of Southern Coast Range Station.

	No. 1147. Sandy Loam Soil.
Coarse materials >0.5mm	39.5
Fine earth	60.5
	100.0
Analysis of Fine Earth.	
Insoluble matter	85.12 } 90.8
Soluble silica	5.57 }
Potash (K_2O)	.68
Soda (Na_2O)	.31
Lime (CaO)	.34
Magnesia (MgO)	.37
Br. ox. of manganese (Mn_3O_4)	.04
Peroxide of iron (Fe_2O_3)	3.83
Alumina (Al_2O_3)	1.74
Phosphoric acid (P_2O_5)	.07
Sulphuric acid (SO_3)	.03
Water and organic matter	2.19
Total	100.29
Humus	.66
Ash	.79
Hygroscopic moisture (absorbed at 15° C.)	1.84

"The sandy nature of this soil is well shown in the large proportion of inert matter and the low moisture-absorption; so low, in fact, that but for the great depth at all points it would constitute a serious defect, and would necessitate very frequent irrigation. But as there is a scarcely noticeable change in the nature of the soil for eight feet or more, both moisture and nourishment can be brought up by the roots independently of the surface soil. As a matter of fact, however, moisture, sensible to the hand, is always found in this land at a depth of six or eight inches, and the roots of smaller plants are usually found unhurt by drought or heat much nearer the surface. There is an abundance of potash present with a relatively small proportion of lime, which, however, does not amount to a deficiency in so sandy a soil, and still imparts to it the characters of a calcareous one. For so sandy a soil, again, the supply of phosphoric acid is quite large, especially in view of the great depth to which the roots can readily go. The supply of humus is only fair, and might be advantageously increased."

Physically, this soil seems well adapted to the culture of the beet, possessing, as it does, depth, moisture, porosity, lightness, and good drainage. In its chemical character, however, while there is an abundance of potash and phosphoric acid, and perhaps of lime, there is lacking the humus which, as the store-house for nitrogen, is so important for beets, and to whose deficiency may be due the relatively low grades produced on this soil, as shown in the following table giving the tests with five varieties of seed:

Analyses of Sugar-Beets from the Southern Coast Range Station, San Luis Obispo County.

	No. 1. Florimond Deprèz.	No. 2. Dippe's Vilmorin.	No. 3. Simon Le Grand's Improved.	No. 4. Bulteau Deprèz.	No. 5. Dippe's Kleinwanzlebener.
Average weight of beets (grams)	120	690	750	885	580
Amount of juice (ccm.)	650	300	400	425	250
Specific gravity of juice	1.0530	1.0674	1.0630	1.0610	1.0570
Solid contents	13.1	16.4	15.4	15.10	14.10
Cane sugar	----------	12.44	13.06	10.71	----------
Purity coefficient	----------	75.85	84.15	71.45	----------

Of these varieties, there are but two which are above the minimum limit of profitable sugar-making, viz.: the *Dippe's Vilmorin*, which is barely within the limit, though its sugar content is fair, and the *Simon Le Grand's Improved*, whose sugar content and purity coefficient are both a little above the average. Supposing that the conditions attending the culture of all of the varieties were similar, the latter variety is clearly the best and the only one adapted to this soil. By reference to the results of the Foothill Station, given on a previous page, it will be seen that there this variety does not take precedence, but ranks second.

COMPARATIVE TANNIN ASSAYS OF CAÑAIGRE ROOTS GROWN IN CALIFORNIA.

Graduating Thesis, by CHARLES S. BONNER, Class of 1890.

The cañaigre is the root of a species of dock (*Rumex hymenosepalum*) which grows wild in Texas, Arizona, New Mexico, Southern California, and parts of Mexico. It has been long used for tanning purposes by the Indians, and also of late years by the tanneries of those districts. Though its use has been very limited in the past, it is highly probable that, on account of the large amount of tannin in the root, its culture will be greatly extended, and that it will become a very general and valuable tanning material. As it grows well, in its native country, in a dry, sandy soil, almost unavailable for any other purpose, many parts of the State might be advantageously employed in growing it, provided the climatic conditions are favorable.

In order to test the growth of the plant in this State, some of the roots were planted in the University Experimental Garden, at Berkeley, in 1884. It now shows a vigorous growth. The tuberous roots are very thickly clustered at the base of the plant, and are nearly all of large size. The samples of which these analyses were made, with the exception of two which came from Colton, California, were taken from roots of the plants grown at Berkeley. The results of these analyses were very satisfactory, showing that the plants will flourish as well and store up as much tannin in its roots in this State as in its native country. In fact, the samples from Berkeley gave a very much higher tannin-percentage than was found in a root from Texas, the analysis of which is given in the report of the United States Department of Agriculture for the year 1878. The latter gave but 26 per cent of tannin, while the average of the analyses, summed up below, is about 36 per cent. Another root from Texas, however, was analyzed in the Agricultural

Laboratory at Berkeley (report for year 1884), and gave 38 per cent, which will be seen to agree very closely with the results given below.

Internal Structure of Root.—The root of this plant resembles a sweet potato in shape, varying in diameter from one half an inch to two inches. Upon cross-section it presents a somewhat concentric cell-structure. The texture of the root is soft and delicate throughout, with the exception of a zone near the outer surface, which is of a firmer, more woody fiber. In an ordinary root of about an inch and a half diameter, the woody zone would be about one quarter of an inch thick, and would be situated between the inside core of soft cellular matter—from three quarters of an inch to an inch in diameter—and an outside narrow zone of soft matter, not more than an eighth of an inch in thickness. When freshly cut, the softer tissue is colored a bright yellow, which, on exposure to the air, changes gradually to a reddish brown, the woody layer being white. Through this white matter, however, are found concentric rings of yellow. Some of the roots have only a small amount of coloring matter.

Microscopic Character of the Root.—The cell-structure of the root is very delicate in all parts except the woody fiber, the cells of which are very much thicker than the others. The partial yellow coloration of the root is due to a yellow oil or resin, which completely fills a great many of the cells. In the woody fiber, which to the naked eye appears to be colorless, these yellow cells are also found, but very much more dispersed than in the other parts. A great many ducts run through this part of the root, and around these the yellow cells are collected in large numbers, giving rise to the appearance of the concentric rings of yellow matter spoken of above.

Starch grains are very thickly scattered through the whole root. The analysis of the root found in the report of the Department of Agriculture, before mentioned, gave 18 per cent of starch. These grains, when viewed under the microscope, had every appearance of starch grains, and it was attempted to stain them with an iodine solution. The iodine, however, did not diffuse sufficiently through the cell membranes to give a characteristic reaction, and it was necessary to use the powdered substance to get a satisfactory test. The starch grains could then be distinctly recognized, colored by the iodine.

Location of the Tannin.—Besides the cell walls, the yellow coloring matter, and the starch grains, nothing can be seen which would show that the tannin is in any other form than in solution. This conclusion was regarded as the only possible one, and it was attempted to color the tannin with an iron compound (ferric sulphate and chloride being used) for examination. The results, however, were not very satisfactory. The iron salts did not seem to diffuse thoroughly through the cells, although sections of the root were allowed to soak for over twelve hours in the mixture, and the coloration was confined to the cell walls. The failure of the iron salts to diffuse through the membranes was possibly due to the formation of the insoluble tannate of iron directly upon the cell walls. The sap, however, wherever squeezed out of the root, gave a characteristic coloration, with ferric chloride; and even the knife-blade, used in cutting sections, was covered with a black stain. Thus, the proof that the tannin is in solution in the sap of the root, seems conclusive.

Determinations of Tannin.—The method employed in making these tannin determinations was, to extract with ether, evaporate to dryness,

dissolve in water, and titrate for tannin. The ether solution contains, besides the tannin, the yellow coloring matter, which is slightly soluble in ether, and almost insoluble in water. The amount of coloring matter dissolved by the ether is quite small, so that the weight of the extract, after evaporation of the ether, should be but little more than the tannin found by titration. This weight was used in all cases as a check upon the work. The percentages were calculated upon the substance dried at 100 degrees C.

In the statement below, samples Nos. 1 and 2 were from Colton, Cal. No. 2 was very much blackened and apparently decomposed, which is probably verified by the result of the analysis.

Nos. 3–8 were from Berkeley, and were gathered on April 10, 1889.

No. 9 was also from Berkeley, but was gathered May 20, 1889.

Nos. 1 and 2 compared, show the amount of tannin found in the same roots dried in different ways. No. 1 was sliced and dried, and No. 2 was dried whole. Both roots were very small.

Nos. 3 and 4 give a comparison of the amount of tannin in roots of different colors.

Nos. 5 and 6 were compared to show where the tannin is principally contained in the root. This knowledge is of practical interest.

Nos. 7 and 8 give a comparison of the amount of tannin in small and in large roots.

Determinations of Tannin in Cañaigre Roots.

No.	Character of Sample.	Ether Extract —Per cent.	Tannin—Per cent.
1	Roots sliced and dried	16.90	16.90
2	Roots dried whole	7.65	6.09
3	Root with little coloring matter	35.76	34.76
4	Root with large amount of coloring matter	39.50	35.14
5	Outside sections of root	33.49	31.20
6	Inside sections of root	47.97	45.80
7	Small root	43.93	41.79
8	Large root	40.77	38.51
9	Root obtained May 20, 1889	35.06	34.12

Nos. 1 and 2 give very poor results. No. 2, as has been stated, was dried whole, and gave evidences of being decomposed. None of the tissue of the root was visible, its appearance being similar to a compact mineral body. From this fact the following conclusion of practical importance is to be drawn, viz.: that on account of the extreme liability of aqueous solutions of tannin to decomposition, it is necessary, in order to dry the roots without deterioration, to facilitate and hasten the evaporation of water by cutting them into thin slices.

By a comparison of Nos. 3 and 4, it will be seen that the tannin-percentage bears no direct relation to the amount of coloring matter in the root. It is also seen that the coloring matter is more or less soluble in ether, and to a less degree in water. The tannin per cent of No. 3 (the light-colored root) was very nearly equal to that of the ether extract (35.76 per cent; the ether extract corresponds to 34.76 per cent of the tannin). Comparing this with results of No. 4, the dark-colored

root, we find that 39.5 per cent of ether extract gives only 35.14 per cent of tannin.

Distribution of the Tannin in the Root.—From a comparison of Nos. 5 and 6, we see that the inside parts of the root give more tannin than the outside. The samples were taken so as to divide the roots into very nearly equal parts, cutting out an inside core about equal to one half of the root. These samples gave very wide differences in results, as would be expected. The woody layer being quite near the exterior surface was cut with the outside sections. This woody tissue contains a very small amount of tannin, as compared with the other parts of the root as may even be easily detected by the taste. This is natural, as the tannin is, doubtless, in solution in the sap of the root, and would therefore be confined mostly to the softer and growing parts.

The smaller roots contain less of the thick and heavy woody tissue and more of the soft growing parts, and therefore give a large percentage of tannin, as will be seen from No. 7. No. 8, a very large root, gave more tannin than was found in most of the other roots; but this is probably not due to the size of the root, all being liable to vary more or less in the tannin-percentage.

Time of Gathering.—Sample No. 9 is of a root picked May twentieth, having been allowed to remain on the plant nearly six weeks longer than the others. It does not show any increase in tannin over Nos. 3 and 4, thus showing that the roots may be gathered at any time after the plants have ceased flowering.

PRESERVATIVE FLUIDS FOR FRESH FRUITS.

By E. W. Hilgard.

(*Experiment Station Bulletin No. 86; May, 1890.*)

As the fruit season approaches there is a constant inquiry for some mode of preserving fruit samples for exhibition at the several fairs. As a general answer to inquiries of this kind that have already come dropping in, I give the following data in regard to the more successful preservatives that are within reach of the practice of any intelligent farmer. I preface them with an explanation of the demands made upon such preservative methods, for the benefit of those to whom the subject may be new, in order that they may better adapt their practice to circumstances.

1. *The preservatives must prevent all fermentation, moulding, or other fungous attacks.* This, of course, means that the outside of the fruit, and the air or the liquid around it, shall be "sterilized" in some way compatible with the preservation of the form, at least, of the fruit or vegetable. This, again, excludes any considerable heating, such as is necessary in "putting up" fruit for eating purposes. We are practically reduced to the use of antiseptics, acting at the ordinary temperature. Among these we have to choose between gases and liquids; but as the manipulation of gases does not come within the condition of easy practicability in an ordinary household, we are further confined to the use of liquids only; the more, as these help to prevent damage in transportation, by removing the greater part of the weight of the individual fruits, that would otherwise tend to deform them. Hence,

2. *The preservative should be a liquid.* This liquid, besides being an efficient antiseptic, should not exert any solvent or softening action upon the skin of the fruit. This condition excludes from the outset all *alkaline* solutions (such as, *e. g.*, cyanide of potassium, silicate of soda, etc.) and all the stronger acids, including acetic acid or vinegar.

3. *The antiseptic fluid should not extract or change the color of the fruit.* This is one of the most difficult conditions to fulfill, and yet one of the most essential. It excludes at once so excellent a preservative as alcohol, and many others that would otherwise be available; among others, common salt, which is available at most for green fruit.

4. *The preservative fluid should neither cause the fruit to swell, so as to increase its size,* and sometimes burst it; *nor should it have the opposite effect of causing it to shrink.* This implies that in the exchange that will unavoidably occur between the juice inside and the fluid outside, the two shall pass through the skin with about equal rapidity. According to well known physical laws, this necessitates that the two liquids shall be approximately of the same density. Thus, if the fruit to be preserved were grapes containing a juice showing 25 per cent by spindle, the fluid outside ought to be made of the same density. If not, the fruit will either shrink or swell, at least at first; in some cases the original bulk will ultimately be recovered; but usually, particularly in thick-skinned fruits, the change is more or less permanent. Thus, in pickling ripe olives, the size of the fruit may be materially reduced, and their substance toughened when too soft, by the use of strong brine. The same is preëminently true of fruit preserved in alcohol or in strong syrup.

Whatever, then, may be the kind of antiseptic employed, this condition of approximately equal densities of the fruit juice and preservative fluid must be fulfilled if the former is to maintain its natural size, especially if the fruit be soft or thin-skinned.

The use of sugar to bring up the antiseptic solution to that of the fruit juice naturally suggests itself, and with some fruits very good results may be obtained in that way. Still, sugar itself being easily fermentable and liable to change tint when not very pure, it is preferable to use *glycerine*, which can now be obtained so cheaply as to render it available to all, and which is, for practical purposes, unchangeable when so used. According to actual trial, commercial "pure" glycerine will act very satisfactorily when used per cent for per cent *by weight* in place of sugar. To do this by *liquid measure*, use four fifths per cent of glycerine as equal to one per cent of sugar. Like alcohol, however, glycerine exerts a slight solvent action upon many fruit colors, *e. g.*, that of cherries, blackberries, etc.

Common salt has the disadvantage of darkening all vegetable colors after a comparatively short time; and *Glauber's salt*, *alum*, and other commonly available salts exert a not inconsiderable solvent action upon colors, which renders their use inadvisable.

It is not always, of course, easy to ascertain the density of the juice of fruits, but the housewife or farmer may rest content with the following approximations to the soluble matters of fruit juices for *ripe* fruit:

Apples and pears, about	12 per cent.
Plums, prunes, apricots, and peaches, about	16 per cent.
Cherries, about	12 per cent.
Most berries, about	8 per cent.
Currants	10 per cent.
Grapes, in California	18 to 30 per cent; average, 24 per cent.

It is only in very tender-skinned fruit that a per cent or two, more or less, will make a difference in the result.

Of antiseptics, the following are the most available: *Salicylic acid*, *boracic acid*, *sulphurous acid* and its compound, *bisulphite of soda* (and of lime), and last but not least, *bichloride of mercury*, or corrosive sublimate.

Salicylic acid, or its compound with soda, both obtainable in commerce, is one of the best and most energetic antiseptics. Its use in spirituous fluids is but too well known; in watery solution it is not so much used, on account of some difficulty in making it dissolve, particularly when the water is cold. An ounce of the acid dissolves in a little less than five gallons of water at the ordinary temperature; but when it is simply thrown *on* the water it may float there a long time, being very light, and many persons will think that it will not dissolve in that proportion. In hot or boiling water there is no difficulty, and the solution is made very easily by the addition of a little carbonate of soda (sal soda) even without heating. But when making use of the soda *it is absolutely necessary to avoid an excess*, as the uncombined soda exerts a very injurious influence upon the preservation of fruits. *A solution of one ounce of salicylic acid to five gallons of water, to which as much glycerine has been added as corresponds to the density of the fruit juice* (see above), constitutes a preservative fluid which has been used with very satisfactory results heretofore. Trouble has arisen from the use of too much soda in making the acid dissolve; as already stated, with patience or heating, the water alone will dissolve the acid, and soda need not be used at all.

Boracic acid, while an excellent preservative so far as the mere prevention of decay or fermentation goes, is more liable than the salicylic to soften the skin and alter the colors of fruit, acting in that respect, in some cases, like alkaline solutions. It is, therefore, not well adapted to long conservation of samples in their natural aspect, but will do well for a few weeks with most fruits. Use the solution as strong as water will make it, which is about five ounces per gallon.

Sulphurous acid, the same substance of which the use is so much abused in fruit drying and in the treatment of wines, can also be employed in solution for the preservation of fruits. This solution may be made directly from the gas of burning sulphur—by an operation sufficiently familiar to cellarmen, and described below. It is, however, more convenient and just as good to use in combination with soda, viz.: the "bisulphite" of soda (not that of lime, used in bleaching saccharine juices, as it will form deposits upon most fruits), heretofore sold under the fanciful name of "California Fruit Salt," and recommended for use in canning fruit for human consumption. Those whose digestion is better than necessary, and who do not object to the sulphurous flavor of the fruit so preserved, may choose to use the preparation. Its merits as an antiseptic are unquestioned; its bleaching effects are equally so, and, as in sulphuring wines, the natural colors will suffer more or less from its use, as well as from that of the acid solution. Use five to eight ounces per gallon.

The following mode of preparing a preservative fluid with sulphurous gas, obligingly communicated by Manager J. Q. Brown, has been very successfully used at the rooms of the State Board of Trade at San Francisco:

"Put thirty gallons of water into a forty-gallon barrel; float on top of

the water a tin pan, in which put a portion of 25 cents' worth of sulphur. Set the sulphur on fire and cover tightly until the fire goes out; renew the sulphur until the whole is consumed, opening the barrel for renewal of air between doses."

While this mode of proceeding is somewhat wasteful of sulphur, and could be improved upon by cellarman, yet it is so simple, and sulphur is so cheap, that it may well be recommended for use on the farm.

Quite lately the use of *mercuric bichloride*, or *corrosive sublimate*, for this purpose has been brought prominently forward by Prof. P. Pichi, of the laboratory for botany and vegetable pathology in the Royal Viticultural School of Conegliano, Italy. In an article published in the April number of the official journal of that school, Professor Pichi discusses the requirements for the preservation, especially of collections of grapes, probably the most difficult of all. He states, that after experimental trials of all the usual preservative solutions, such as alcohol of various strengths, and of watery solutions of salicylic, boracic, and other acids, and salts of copper, he finally made trials with solutions of corrosive sublimate, ranging from 1 to 4 *pro mille* in strength. After two months all were still in perfect preservation, both as to color, form, and size, and the berries remained firmly attached to their stems. After five months, the fruit in the 1 *pro mille* solution was in a decidedly unsatisfactory condition, and after the first year, unfit for study; while those in the stronger solution were in good condition, but the fluids were of a slightly reddish tinge, particularly in the 2 *pro mille* solution. After four or five months more, this difference against the weaker solutions was still more pronounced, and it was evident that 3 *pro mille* is the least strength compatible with good conservation. A second series of experiments confirmed this, and pointed to a solution of 4 *pro mille* as probably the best. The final conclusions are stated as follows:

"From all that I have reported I believe that I am able to conclude that grape bunches can be best preserved for collections by keeping them immersed in a solution of corrosive sublimate, taking care to wash them thoroughly beforehand with water. At first we will use a solution at 3 *pro mille*, and after some time we replace this with a solution at 4 *pro mille*. About the end of the second year we will renew the solution, and we shall thus have assured their preservation for a number of years, and with but a trifling expense."

The author finally calls attention to the poisonous nature of the preserving fluid, which is, however, the same as in pathological laboratories for the disinfection of hands and instruments after use in anatomical dissections.

The strength above referred to as the best is equal to *half an ounce of corrosive sublimate to a gallon of water*. Nothing is said by Professor Pichi regarding the addition of glycerine or anything else to correct the density of the solution; and it is possible that the hardening of the grape skins, caused by the action of the sublimate, renders such addition unnecessary.

If so, this would certainly be both the most perfect and the cheapest method of satisfactory preservation thus far found, the possibility of dangerous mistakes for such specimens of ordinary "put-up" fruit alone excepted. Its merits, with respect to other fruits than grapes, are now under trial at this station, and will be fully tested during the coming season on all available fruits.

The solution should properly be made with *distilled* water. Whe this is not available, other water may be used—preferably that from th larger streams; but (particularly in the case of well water) it shoul first be boiled and allowed to clear by settling, before dissolving th sublimate. Even then a whitish or grayish turbidity and sediment wi usually form after awhile; this should be allowed to settle fully befor putting the fluid over the fruit. It would be well to label all such fru jars "POISON," for the sake of safety. No metal must come in contac with the sublimate solution, as it would be quickly decomposed.

[Experience had since the publication of the above article suggest the following points:

The solution of corrosive sublimate, prepared as above prescribed, an with the proper addition of glycerine to prevent shrinking or burstin of the fruit, insures a very perfect preservation of the form and size o the fruit. The color is not extracted, but is marred materially by a deposit of a whitish powder (calomel) on the surface of the berries giving a ghastly appearance. This deposit is not mentioned by Pro fessor Pichi, perhaps because it is really of little consequence in th preservation of specimens for instruction; but few would desire to ex hibit their fruit in such unattractive exterior guise. In the case of thi solution, the exclusion of air appears to make no difference, so long a evaporation is prevented.

The use of the solution of sulphurous gas, with a proper addition o glycerine, and with exclusion of air (to prevent the escape of the sul phurous gas), therefore in glass-stoppered or otherwise well sealed jars is the next best preservative so far as form is concerned, but it bleaches all colors very sensibly in the course of a few months, and while the fruit is not thus made to look as ghastly as in the case of the mercurial solution, white cherries, plums, and strawberries, and oranges of a light lemon yellow, are not very natural-looking; yet, if the fruit has not to be kept very long, this solution supplies an easy mode of preserving it intact, if not with its full color.

The solution of salicylic acid, or salicylate of soda prepared as above indicated, and kept from access of air by tight sealing, acts very well and does not bleach the colors; but in the case of deeply colored fruits such as cherries and blackberries, the color is extracted and imparted to the fluid in the ratio of its bulk to that of the fruit. There is thus, at least, an indication left of the intensity and tint of the original color, which in the use of the sulphurous solution is lost entirely, and in that of the mercurial one veiled by the film of calomel.

Experience also suggests that inasmuch as all fruits, when they are to be preserved for exhibition, are gathered before full maturity in order that they may not be too soft for handling and transportation, therefore the full amount of sugar given by the analyses quoted in the above table is not yet present as it was determined in fully ripe fruit. Hence, in some cases, the full amount of glycerine prescribed caused contraction, from which the fruit (especially cherries) did not recover fully. It would seem advisable to reduce the above figures to two thirds or even to one half, according to the stage of ripeness at which the fruit has been gathered.

Experiments with the bisulphite of soda ("California Fruit Salt") are in progress and may yield more satisfactory results than the free sulphurous acid of the solution prepared as above. The use of this salt would have the advantage that the strength of the solution could be accurately gauged by the weight of the salt used to each gallon of water.]

THE SULPHURING OF DRIED FRUITS.

By E. W. HILGARD.

(*Experiment Station Bulletin No. 86.*)

The writer's views on the above subject have been so often expressed before meetings of fruit growers, and in print before the general public, that it might seem uncalled-for to reiterate their formal expression in this place. Yet the frequent requests, both written and verbal, for such expressions seem to render it the briefest mode of disposing of the subject; the more, as the only radical solution of the question lies in its being more and more fully understood by consumers (to whom these presents are equally addressed) who now sacrifice good flavor and healthfulness to mere appearance.

The sulphuring of dried fruit has two chief objects. One, and that most generally kept in view, is the brightening of color, which always darkens, particularly in sliced fruit, in whatever way it may be dried, the change of color being due to the action of the air (oxygen) upon certain easily changeable substances contained in *all* fruits. This darkening (mostly to a light brown) is a practically inevitable result of drying *any* fruit in contact with air, whether in sunshine or by artificial heat, and should be looked for by every consumer as the natural mark of an honest, unmanipulated article.

The second object sought to be attained by sulphuring is to render the fruit secure from the attacks of insects, whether by rendering its surface unpalatable before the eggs are laid, or by killing eggs laid during sun-drying, that might subsequently hatch in the packages. The latter object involves, of course, the sulphuring of the *dried* fruit; while the former is, to a greater or less extent, attained by sulphuring *before drying*.

The effects of sulphurous acid (the gas, not the visible fumes given off from burning sulphur) as a disinfectant and bleaching agent, are generally understood. The gas is absorbed by the moisture of the fruit, to an extent dependent upon the time of exposure, its fresh or dried condition, and the amount of sulphur used. When freshly sliced fruit is sulphured *for a short time*, the gas penetrates only "skin-deep;" and when the fruit is afterward dried, whether in the sun or drier, most of the gas escapes and few persons would note the difference in taste produced thereby. Insects, nevertheless, are to a material extent deterred from touching such fruit.

But when the latter is dried and *then* thoroughly sulphured, as is too commonly done, the effect is much more serious. The gas then penetrates the entire spongy mass, bleaching it, so that carelessly dried fruit, too dark to be marketable, can thus be made to appear more or less inviting to the eye. Not, however, to the nostrils or to the taste, for with the color the *flavor* has also suffered correspondingly; and upon

opening a package of such fruit, instead of the natural aroma, there appears the flavor familiar to those who visit a chemical laboratory or acid manufactory.

The consumer then has reason to object to dry-sulphured fruit on two counts, either of which is sufficient to condemn the practice. One is that dirty, ill-prepared, or damaged fruit may thus be imposed upon him for good quality; the other, that the natural flavor of the fruit is either seriously impaired or sometimes almost completely destroyed, and (as will be shown) its acidity greatly increased.

There is another and very serious count in the indictment, namely, that such fruit is unhealthy because containing an antiseptic that impedes digestion, and, while the fruit is relatively fresh, causes headaches, just as will sulphured wine. After some time the "sulphurous" acid originally introduced becomes converted into "sulphuric" acid, a condiment that few will desire to consume in their daily food. The precise extent to which this may be present is shown in the subjoined analyses, respectively of apricots sulphured before, and of "silver prunes" sulphured after drying, as found in the market:

	Total Acidity.* Per Cent.	Sulphuric Acid (SO_3) Per Cent.
Non-sulphured apricots		.067 (combined)
Sulphured apricots		.282 (mostly free)
Non-sulphured prunes	.321	.056 (combined)
Sulphured prunes	.544	.346 (mostly free)

In considering the above results, it should be understood that the sulphuric acid, given as contained in the unsulphured fruit, is present in the form of "neutral salts," such as occur in the ash of all vegetable products; while that which is added in sulphuring exists in the form of free acid.

It will be seen that in the case of the apricots the increase was to the extent of about twice and a half the amount originally present, although these were reported to have been sulphured only *before* (more probably *during*) drying. Their lack of natural flavor and pungent acid taste at once revealed the effects of sulphuring.

In the prunes which had been sulphured *after* drying, the effect was much more striking. Here the increase was over *six* times the natural contents. The total amount added by sulphuring amounted to nearly a third of 1 per cent, and the free sulphuric acid in the dried fruit amounts to .22 per cent, which is equivalent to about twenty-five grains of commercial oil of vitriol per pound.

In addition to rendering the fruit unpalatably acid, it has been rendered obnoxious both to the digestive organs and to the teeth. No one could habitually consume such fruit without feeling the effects of such an amount of mineral acid, introduced into his food purely for the gratification of the eye with an unnatural tint.

But so long as the public and its agents, the dealers, continue willing to pay from 30 to 50 per cent more for the whitened sepulchres offered them in the shape of sulphured fruit, than for that which retains, with its natural flavor and sweetness, the natural tint of dried fruit, and with it the marks of careful or careless treatment, so long will the producer

*Expressed in terms of sulphuric acid.

continue to supply the demand for the doctored article; unless, indeed, the law should intervene, as has been done in most European countries. There the sale of sulphured fruit is simply forbidden as injurious to public health, and as coming under suspicion of having been "doctored up" from an inferior article, with fraudulent intent.

When, therefore, it is asked what I think is the proper policy to be pursued in this respect, by a region which this year will, for the first time, come into the dried-fruit market, I reply that I think that the time has come to make a step forward and try to put upon the market a first class article of "unsulphured dried fruit," with the express statement and claim that it *is* unsulphured and retains the natural sweetness and flavor of California fruit, instead of being reduced to a common level with the worst products of any other country. For it is certain that the whitish-green dried apples and pears now sold at high prices in our grocery stores, might just as well have been grown anywhere from Norway to the Mediterranean, for aught they teach of the quality of our fruits.

The following suggestions are offered to those who are willing to practice sulphuring to a moderate degree only, and with some regard to the conservation of the fruits' palatableness:

Large quantities of sulphur introduced at once into the drier or sulphuring box will tend to cause a deposit of sulphur, in substance, on the outside of the fruit, adding its flavor to that of the acid, which alone is useful. The less sulphur is put in at one time, and the more air admitted, the less there will be of the visible fumes that carry the sulphur up into the fruit. It is best to let the sulphur catch fire *all over* before putting it into the box at all.

Let whatever sulphuring you must do be done *before* drying, as in that case not only will the drying process itself drive off a great deal of the sulphurous acid and prevent it from penetrating the whole, but the flavor of the interior will penetrate outward and measurably do away with the laboratory odor that will otherwise pervade the fruit package.

A very sightly and appetizing cinnamon-brown tint for sliced apples and pears may be secured by dipping, for a few minutes, the freshly-made slices, contained in a properly shaped basket (of galvanized wire if desired), into a solution of salt containing not less than two ounces in five gallons of water. This prevents any spotting where the fruit has been touched. Instead of the salt, a similar solution of the bisulphites of soda or lime may be used, which effect a slight external bleaching without injury to the flavor of the fruit.

Last, but not least, let us try to gradually educate the public taste up to the point of preferring in this matter the substance to the shadow, and accepting healthy, brown, high-flavored dried fruit to the sickly-tinted, chemical-tainted product of the sulphur box.

VI. FERTILIZERS, ETC.

THE USE OF FERTILIZERS IN CALIFORNIA.

By E. W. HILGARD.

(*Experiment Station Bulletin No. 88; October 6, 1890.*)

The fortieth anniversary of the admission of California into the Union reminds us that she has ceased to be a stripling. With this advance in dignity comes the inference that however fertile her soils, it is to be expected that those long occupied, or heavily cropped, will now require serious care in order to keep up or restore production. That this is really so is proved by the rapidly increasing correspondence on the subject that is addressed to this Station; and to avoid the unnecessary rehearsal of general statements in each individual case, it seems desirable to put in print for general information what can be stated in a general way on this subject. Of course, many individual cases will still require special consideration on account of peculiar conditions of soil or location; for in a great many instances, the failure to produce satisfactory crops is not at all due to soil-exhaustion, but to improper physical conditions of the subsoil, unsuitable cultivation or irrigation, alkali, etc. The fact that orchards and vineyards form costly investments of much greater permanence than the annual crops that occupy the vast majority of the cultivated land east of the Rocky Mountains, and the high returns so often realized from them, has brought the manure question forward here much earlier than has usually been the case in the United States; and happily, the silly adage that "manuring is too costly, and will never pay," which has long kept agriculture on the down grade elsewhere, has never had a serious foothold in California. The sovereign truth that nothing pays worse than poor crops upon large areas of which the cultivation costs just as much as if it were yielding high returns, is quite generally appreciated here. Cultivating too much land poorly, and getting poor returns both as to quantity and quality, has been the bane of farmers all over the East, and has doubtless done at least as much toward "agricultural depression" as all other causes combined.

But whether fertilization will pay or not clearly depends directly upon the particular requirements of each soil. Unlike Europe, where long cropping has reduced all soils alike to a condition when they require an "all around" fertilizer, the soils of California have mostly had a *one-sided wear* from the constant succession of one and the same crop. In orchards and vineyards this state of things is unavoidable, since they are expected to last twenty to forty years without renewal, or possibility of rotation of crops. It is this one-sided wear, inseparable from the chief horticultural industries of the State, that requires special attention at this time; for it is clear that to apply "complete" fertilizers in these cases, would be to pay out a portion of their cost uselessly, since nothing can be gained by adding to the soil more of the ingredients that are already abundantly present in available form.

In order to fertilize intelligently we must know, first of all, what ingredients are chiefly drawn upon by the crop sold off the land; secondly, we must know which of these ingredients are so abundantly present in the soil (or irrigation water, as the case may be) to render their replacement unnecessary for the present at least.

The subjoined table gives some insight into the amounts removed by the soil by some of the chief fruit crops, of nitrogen, potash, phosphoric acid, and lime; these being, according to all experience, the only ones of which the replacement need ordinarily be considered in fertilization. These amounts are expressed both with reference to one thousand pounds of fresh fruit, and to what, according to our best information, may be assumed to be a "fair crop" per acre. The latter figure is, of course, liable to great variations and differences of opinion; but, by the aid of a little arithmetic, each one can calculate for himself the data suitable to his own case or views. The crop assumed in the case of oranges is 325 boxes per acre of fifteen-year-old trees; that of grapes is intended to represent a mean between upland and lowlands.

*Quantities of Soil Ingredients Withdrawn by Various Fruit Crops.**

Fresh Fruit.	Ash—Pounds.	Potash—Pounds.	Phosphoric Acid—Pounds.	Nitrogen—Pounds.
Grapes—1,000 pounds	8.8	5.00	1.52	1.70
Crop of 10,000 pounds per acre	88.0	50.00	15.20	17.00
Oranges—1,000 pounds	6.1	2.78	.67	2.69
Crop of 20,000 pounds per acre	122.0	55.60	13.40	53.80
Pears—1,000 pounds	3.3	1.80	.50	.60
Crop of 20,000 pounds per acre	66.0	36.00	10.00	12.00
Plums—1,000 pounds	2.9	1.72	.44	4.20
Crop of 30,000 pounds per acre	87.0	51.60	13.20	167.70
Apples—1,000 pounds	2.2	.80	.30	.60
Crop of 20,000 pounds per acre	44.0	16.00	6.00	12.00

It will be seen that for equal weights of these fruits, *grapes* take from the soil by far the largest amount of mineral matter, of which nearly five ninths is potash; they also carry off the largest amount of phosphoric acid. For seedless grapes the latter item would, however, be considerably smaller.

Next in the drain of total mineral matter from the soil stands the *orange;* it also draws heavily on the potash, and also upon the nitrogen of the soil, but less than the grape upon phosphoric acid; this independently of the seeds, the analysis having been referred to seedless fruit; seed-bearing (seedling) fruit would presumably draw more heavily both on phosphoric acid and nitrogen.†

Pears come next as regards total mineral matter, but draw quite lightly on nitrogen.

Plums (including prunes) are conspicuous chiefly for their heavy draught on the nitrogen of the soil, greatly exceeding in that respect the orange for equal weights, and enormously for an (assumed) average crop.

The difference between *apples* and *pears* in respect to soil-exhaustion

* The analyses of ashes here given are mostly those of European chemists, generally accepted as representing averages. California-grown fruits will be investigated at this Station the coming season for this purpose.

† Late analyses of California oranges seem to show no material difference between seed-bearing and seedless fruit.

for an equal weight of fruit is quite striking, the amount of potash in apples being less than half, the phosphoric acid only a trifle over half as much as in the pear; while nitrogen is equal in both, and quite low as compared with the orange, which has over four times as much, and must therefore be accounted relatively much more nourishing to man, as well as more exhausting to the soil.

While the data given above, in relation to the "outgo" of soil ingredients, through the harvesting of the several fruits, may be considered as holding good, practically, in all countries and on all soils, the vast differences in the nature and composition of *different soils* introduce an element of uncertainty as to the need of returning to every soil the full amount of the outgoing ingredients. Few soils are about evenly constituted with respect to the four important plant-food substances. There is, in most cases, one or several of these present in superabundance, so that to replace the small amount carried off by the crop would be as useless as "carrying coals to Newcastle;" at least for the present. *The analysis of soils and irrigation waters is necessary to gain information on these points.*

As regards waters, the information so obtained is positive and unimpeachable. Whatever is dissolved in the irrigation water is absolutely available to vegetation, and the amount annually so conveyed to the soil is capable of close calculation on the basis of the current practice of each irrigation district. If the amount of any substance so given to the soil approximates to, or exceeds the amount withdrawn by crops, it is quite certain that no money need be expended in the purchase of that particular substance as a fertilizer.

As regards soils, the indications given by chemical analysis are not so definite, because the acids used in the laboratory are more powerful than those at the command of the roots of plants; although some of the latter (*e. g.*, oxalic acid, that of sorrel, rhubarb, etc.) approximate closely to the same solvent power. Here experience must be our main guide, and this has shown that, practically, soils containing (by the results of analysis) more than a certain percentage of a given substance, may be considered as abundantly supplied with the same; while if the percentage so indicated falls below a certain other point, such ingredient may be considered as being deficient. The crucial test in either case is the experimental use of that substance as a fertilizer on the soil in question; when it fails to produce a definite, favorable result, it may be considered that the native supply is sufficient, and *vice versa*.

It is obvious that in order to secure to the farmer this saving of the purchase of superfluous fertilizing ingredients, a comprehensive system of investigation of soils and waters is necessary. This has been from the outset the central thread of the work of this Station; the object being to obtain, as quickly as possible, the facts necessary for the compilation of a soil map of the State. For want of funds for field work, and too limited a force for laboratory work, this fundamental plan has been carried out only to a limited extent, and chiefly in certain regions where considerable interest in agricultural improvement was manifested. We are not, therefore, as yet prepared to give information as to the entire State; and unless some special provision is made it will be long before this can be the case. But, so far as the work has gone, the following points may be considered as practically settled:

1. From climatic, as well as geological causes, nearly all the soils of

the State may be considered as abundantly supplied with *lime*. The chief exceptions occur in the higher portions of the foothills, where the rainfall is high, and summer rains occur. In *all* the valley soils lime is abundant; and liming is, therefore, not among the means of improvement usually to be thought of in California. This applies to the use of quicklime and ground limestones; not necessarily to the use of marls, which usually contain other ingredients besides lime, to render their use valuable, where it can be done with little cost.

2. Almost the same that is stated above of lime may be said of *potash*. The great majority of soils in this State, more especially all valley soils, and absolutely *all* soils in which there is the least manifestation of alkali, contain an abundance of available potash for all agricultural purposes; so much so that dissolved potash salts frequently circulate in the soil water. Most irrigation waters furnish an additional supply, sometimes enough of itself to make up for all that the crops take away. Outside of the rainy belts of the Sierra and of the northwest coast, therefore, the addition of potash in fertilization must, in general, be considered in the light of "carrying coals to Newcastle"—superfluous and unprofitable at the present time; and farmers should object to paying for the potash in commercial fertilizers (put there under the Eastern idea of making a "complete" fertilizer), because the investment will pay them no interest. They should demand for their money the ingredients that will pay them for their use in this State, regardless of what may pay elsewhere.

The few cases in which at present the use of potash *will* pay are those of intense culture in vegetable gardens and berry patches, where crops are grown continuously and successively throughout the season. Here the draught upon the soil ingredients is so heavy that within a few years *all* require current replacement.

3. Of *phosphoric acid*, an ingredient so important that even in Europe it is beginning to be claimed as the practical measure of fertility, analysis has shown an almost universal *scarcity* in the soils of this State, always excepting the alkali soils, in which it, or its compounds, frequently circulate in proportionally large amounts. Phosphoric acid is one of the substances to be first suspected of exhaustion in the non-alkaline soils of California; it is therefore an ingredient that should be prominent in *all* compound commercial fertilizers, and which will be found to "pay" in most cases of decreasing production.

4. As to the fourth of the critical soil and plant ingredients, *nitrogen*, its ordinary measure in soils is the vegetable mould or humus, the presence of which is generally manifested, and outside of "red" soils is fairly measured, by the more or less blackish tint when wetted. From climatic causes, humus is rarely abundant in the upland soils of the State, and very generally its amounts may be said to be small. This is especially true of the mesa soils of the South—those best adapted to the growth of the citrus fruits—and hence it is reasonable to suppose that *a lack of nitrogen* will be among the first things to be apprehended when the fruit shrinks in size and production falls, on these soils.

Elsewhere stable manure is the ordinary source of this as well as of the other substances when required only in moderate amounts; but for many reasons stable manure is less available in the dry climate of California than elsewhere. It is produced only in small quantity in horticultural communities; and when put in the soil it is long in decaying

and becoming effective. It should for our climates be systematically "cured" in the manure-pile before being used—a point of vantage which explains, in part, the good effect of sheep corral manure.

By far the most convenient, and at present certainly the cheapest and most available source of nitrogen at command of the farmer, is *Chile saltpeter*, which contains about 16 per cent of nitrogen in its most effective form. From one hundred and fifty to two hundred pounds per acre is the usual dose; more than this will not be used by the crop plants in one season, and a surplus is likely to be washed out of the soil by the winter rains. Moreover, an excessive application might result in too much wood and too little fruit, and that fruit of a sappy, flavorless character, though of large size.

Sulphate of ammonia is the other most available source of nitrogen obtainable in commerce. A good commercial article contains 20 per cent and over of nitrogen. It does not, however, act quite as rapidly as the Chile saltpeter.

To the citrus growers, then, who at present seem to be most concerned about the fertilizer question, I would say that, well-cured stable and sheep corral manure apart, their best resort at present is to the commercial phosphates and superphosphates of high and honest grade, mixed, either by themselves or by the manufacturer, with a proper proportion of Chile saltpeter or ammonia sulphate, and generally no potash whatever.

In order to cover approximately the ground of the questions most commonly propounded in our correspondence on the subject of fertilizers, the following points are briefly stated:

This Station has no direct or definite knowledge of the quality or "trueness to name" of any of the commercial fertilizers now sold in this State. Analyses of mere samples sent by the manufacturers or others prove little or nothing, so long as no regular "fertilizer control" is established by State authority. That this should be done as soon as possible, in the interest of both the users and honest manufacturers of fertilizers, is manifest; and nearly all the older States have found this regulation of the fertilizer trade necessary long ago. At present this Station declines to analyze, and certify to the composition of fertilizer samples, except in cases of suspected fraud, for the reason that such samples prove nothing as to the general quality of the material put on the market, and their analyses have been used in advertising as though offering a kind of guarantee or recommendation on the part of the Director. The latter disclaims pointedly any such responsibility, and does not authorize the use of his name in connection with any fertilizer advertised. He has, however, no reason to question the *bona fide* character of the several fertilizers manufactured in this State. That in individual cases disappointment must often occur, is natural from the causes stated above, and proves nothing against the honest composition of the goods. In this, as in other cases, the right thing may be put in the wrong place. The useless addition of considerable potash is the objection lying against several of the brands in the market.

Farmers should be willing to pay a good price for a high-grade fertilizer, especially in the case of superphosphates. The only consequence of insisting on too low a price is that the manufacturer, in self-defense, adds to the active matters, enough of some cheap, inert material to be able to afford the lower rate; the result being that the farmer pays

freight, to say the least, on "dirt," which he might as well put in on the spot, if so inclined. "Spent refinery charcoal" in coarse grain is about as unprofitable an investment as a farmer can well make. He should be willing to pay enough to justify the manufacturer in reducing every grain of it to the soluble form by the use of enough sulphuric acid. It is not advisable for any one to attempt to do this at home.

In regard to the use of *bones*, it may be said that any one may, with little trouble, use all the bones accumulating about a homestead in either of three ways:

1. Bones put into a *well kept* (moistened) *manure-pile* will themselves gradually decay and disappear, enriching the manure to that extent.

2. Raw bones may be bodily *buried in the soil* around the trees; if placed at a sufficient depth, beyond the reach of the summer's heat and drought, the rootlets will cluster around each piece, and in the course of a few years consume it entirely. But it will not do to have these root-clusters broken up by cultivation every season.

3. Bones may be packed in moist wood ashes, best mixed with a little quicklime, the mass kept moist but never dripping. In a few months the hardest bones will be reduced to a fine mush, which is as effectual as superphosphate. "Concentrated lye" and soil may be used instead of ashes. In this process the *nitrogen* of the bones is lost, going off in the form of ammonia, the odor of which is very perceptible in the tank used.

For neither of these processes should the bones be *burnt*. The burning of bones is an unqualified detriment to their effectiveness, which can only be undone by the use of sulphuric acid.

4. Bones *steamed* for three or four hours in a boiler under a pressure of thirty-five to forty pounds can, after drying, be readily crushed in an ordinary barley-crushing mill, and thus be rendered more convenient for use. Practically, very little of the nitrogen (glue) of the bones need be thus lost. Very good *bone-meal* is found in the market at reasonable rates.

For information concerning the value and proper use of *land plaster* or *gypsum* (also one of the inquiries continually made), I refer to pages 144 and 145 of the "*Report on the Experiment Stations*," lately issued, which will be mailed free to any one desiring it. It may here simply be stated that while gypsum is not a general fertilizer like the phosphates and nitrates, for the simple reason that it does not contain, and therefore cannot supply, the plant-food substances of which the withdrawal by crops causes sterility: yet its uses, especially in the irrigated regions and on alkali soil, are so many and so important that it should be very widely used so soon as a reasonably cheap supply can be obtained.

ANALYSES OF FERTILIZERS.

Fish guano; sample sent by Messrs. Allen & Lewis, San Francisco; manufactured by the Alaska Oil and Fertilizer Company, Killisnoo, Alaska.

The air-dried substance was found, on analysis, to contain:

Moisture		12.99
Nitrogen, as ammonia (ready formed)	.62	
Organic	10.83	
Total		11.45
Calculated as ammonia		13.91
Potash		.87
Phosphoric acid, insoluble	.80	
Soluble	1.91	
Reverted	3.29	
Total		6.00
Phosphoric acid available (reverted and soluble)		5.20

The nitrogen in the above, while in fair amount, is mostly in the form of organic matter, which needs to undergo decomposition before being available for plant use.

The comparatively large percentage of available phosphoric acid adds value to the guano as a fertilizer, while, on the other hand, the presence of a larger amount of potash will not be needed upon the lands of this State, which already are well supplied. Altogether, this sample compares very favorably with the fish-scrap fertilizers usually put upon the market elsewhere in the country.

Dry "hog tankage" fertilizer; sent by Messrs. Frost & Burgess, Riverside, with request for opinion as to its fitness as a fertilizer for nursery stock. The analysis shows that the sample contains 7.54 per cent of nitrogen, equal to 9.15 per cent of *ammonia.* The proportion of other ingredients was not determined. This is evidently a bona fide article, and will be of high efficacy as a furnisher of nitrogen in place of Chile saltpeter or ammonia sulphate.

Sulphur refuse, from the sulphur works near Shell Mound Station, Alameda County; sent by the Messrs. Sherwood, San Francisco.

"This refuse is from the reduction of sulphur ores, and is composed of sand, loam, lava, ashes, etc. Will it make a good fertilizer?"

An analysis of the sample shows the presence of the following:

Insoluble matter	46.03
Potash	.20
Soda	.30
Lime	.26
Magnesia	.03
Peroxide of iron and alumina	1.10
Phosphoric acid	.10
Sulphuric acid	2.13
Sulphur	37.70
Organic matter and water	12.15
Total	100.00

The amounts of the important elements of plant-food (potash and phosphoric acid) present in the sample are no more than are found in ordinary soils; there is very little lime or magnesia; while on the other hand, the enormous amount of sulphur and sulphuric acid would be a positive injury to any soil.

Guano, from Sophia Island; sent by Messrs. Crawford & Co., San Francisco; the analysis to be compared with those of other samples of the same made by other chemists.

No. 1, made at the University of California Experiment Station.

No. 2, made by Messrs. Thomas Price & Son, San Francisco.

No. 3, made by Mr. J. A. Pond, public assayer at Auckland, New Zealand.

"We presume that the sample of the article we now send you compares favorably with the sample that the above named parties assayed."

The air-dried substance contains:

	No. 1.		No. 2.	No. 3.
Moisture		9.37	5.90	5.36
Nitrogen as ammonia (ready formed)	.08			
Nitrogen as nitrates	.48			
Nitrogen, organic	.66			
Total nitrogen found	1.22			
Nitrogen calculated as ammonia		1.50	2.30	
Potash		.08		
Phosphoric acid, soluble	.27			
Phosphoric acid, reverted	4.28			
Total available	4.55			
Phosphoric acid, insoluble	25.51		24.61	
Total phosphoric acid, available and insoluble		30.06	24.61	31.26
Total volatile matter (organic and carbonic acid, etc.)		26.40	32.25	52.44
Mineral matter (not included above)			34.41	

The above analysis, made only with a view of showing what are the active manurial ingredients of this guano, shows quite material differences in composition, and therefore in value, from the samples of which analyses have been made by Messrs. Pond and Price. We find considerably more phosphoric acid and less nitrogen and organic matter than did Price; while in phosphoric acid we agree nearly with Pond. Considering the large proportions of insoluble phosphoric acid present, the use of some sulphuric acid is advisable, to give it better value, although it will do much good even as it is. Its particular adaptation would be for the orange-growing districts of South California, where no potash is needed, but chiefly phosphoric acid and a moderate amount of nitrogen.

THE FERTILIZING VALUE OF GREASEWOOD.

By E. W. Hilgard.

(*University Experiment Station Bulletin No. 94.*)

A quantity of the dry brush of the greasewood plant (*Sarcobatus vermiculatus*) was furnished by Geo. W. Raymond, of Miramonte, Kern County, the object being to determine whether or not it would pay to use the plant, or its ash, as a return to the soil, or in making composts for general purposes of fertilization.

The table below shows the result as obtained by Mr. Jaffa, alongside of the ash analyses of some other well known plants, for comparison.

Table Showing Ash Composition of Greasewood Compared with Other Plants.

	Grease-wood.	Samphire.	Seaweed.		Cabbage.	Timothy Hay.
			Fucus vesiculosus.	Laminaria digitata.		
Silica	11.81		1.7	1.6	1.2	35.6
Potash	18.53	2.6	14.5	22.4	48.6	28.8
Soda	39.45	36.4	24.0	24.1	3.9	2.7
Lime	1.36		13.9	11.9	15.3	9.3
Magnesia	1.09		9.5	7.4	3.3	3.6
Peroxide of iron and alumina	7.06		1.1	.6		
Phosphoric acid	3.51		3.1	2.6	15.8	10.8
Sulphuric acid	4.93		24.0	13.3	8.5	3.9
Chlorine	15.30		10.1	17.2	2.5	5.0
	103.04					
Less excess of oxygen due to chlorine	3.25					
Total	99.97					
Ash percentage of plant	12.03		14.4	18.6	10.8	7.0

It will be noted that of all the plants here shown, among which are three (samphire, or "salt grass," and the two seaweeds) presumed to contain unusually large percentages of soda, the greasewood shows the largest amount of sodium salts, nearly 40 per cent of the ash being soda, out of which over 25 per cent of common salt and nearly 8 per cent of Glauber's salt are formed. There remains out of the total amount shown in the analysis 23 per cent that will go toward forming carbonate of soda, if returned to the soil, increasing its weight to about 39. This means that out of one hundred pounds of greasewood ash, seventy-two pounds would be "alkali" of the usual composition of "black alkali," which would, at the very least, be of no use to any soil; while to those already charged with alkali it would be decidedly detrimental, as adding so much to the evil already existing.

It is true that there are 18 per cent of potash and 3½ per cent of phosphoric acid to be placed to the credit of the ash, as available and valuable plant-food. But as potash is usually abundant already in the soils upon which the greasewood grows, this would hardly outweigh the disadvantage of the alkali in the same soils. Practically the 3½ per cent of phosphoric acid alone is to be written to the credit of the greasewood ash where it would usually be convenient to apply it, against the disadvantage of a returning of three fourths of the whole ash in the useless or detrimental form of "alkali."

The question still remains, how much of the other important fertilizing element, nitrogen, would be supplied by the *fresh* plant. This has not as yet been determined; when it is, it may turn out that on well-drained soils not too rich in alkali the use of fresh or dried (but not of burnt) greasewood brush would be advantageous.

On the other hand, it may be asked whether in clearing greasewood land it would be an advantage to remove the brush, so as to diminish the alkali, as is done when beets are planted in saline soils.

The fresh plant, including stem and leaves, may be estimated to contain about 75 per cent of water. A ton of the fresh brush would thus contain five hundred pounds of dry matter, of which sixty pounds

would be ash; and of this ash about forty-five pounds would be true, useless "alkali."

If, then, the ground were so thickly overgrown with the greasewood as to furnish about ten tons of brush per acre, to remove that brush would be equivalent to taking away something like a quarter of a ton of alkali. This is not an insignificant amount in soils liable to injury from the excess of salts; and if the process were repeated several times the greasewood would serve, like the beet, to remove a very notable proportion of the total alkali salts present in the soil, just as does the removal of samphire in reclaiming salt-marsh lands. On the other hand, were the greasewood growth only scattering, its removal would serve no practically important object.

Comparison with Other Crops.—Comparing greasewood with the other plant ashes in the table, it will be seen that while it does not agree closely with any of these, it approaches the seaweeds more closely than the samphire in its contents of potash and phosphoric acid. Seaweed is freely used for preparing fertilizing composts in countries where summer rains prevail, and usually on the sandy seashore soils, through which the excess of saline matters (sodium salts) is readily washed into the subdrainage, and consequently does not stay to increase the salts in the soil, as would be the case in our arid climates. It will be noted that they, also, supply considerable potash, much needed in rainy countries, but only a small proportion of phosphoric acid, upon which the food and forage plants draw so heavily, as is seen in the annexed analyses of the ashes of cabbage and timothy hay. Phosphatic fertilizers are, therefore, needful in connection with the use of seaweed (and greasewood) composts in order to supply the demands of the common culture plants.

II.

REPORTS

ON

CULTURE WORK AT THE EXPERIMENT STATIONS.

A. *Central Station;* Alameda County.
B. *Foothill Station;* Amador County.
C. *Southern Coast Range Station;* San Luis Obispo County.
D. *San Joaquin Valley Station;* Tulare County.
E. *South California Station;* Los Angeles County.

REPORTS ON CULTURE WORK AT THE SEVERAL EXPERIMENT STATIONS.

A. CENTRAL EXPERIMENT STATION.

Berkeley, Alameda County.

REPORT ON FIELD WORK AT CENTRAL STATION.

By EDWARD J. WICKSON.

The culture work at the Central Station has been prosecuted under the intelligent supervision of Captain E. Kellner, as foreman. His efforts have resulted in more economical and efficient management and execution.

A general outline of the work carried on during the year, including a number of special features to which fuller allusion is made in other portions of this report, may be sketched as follows:

The *field work* consisted in the main of sowing the whole cereal collection for the continuation of the experiments with the Hessian fly, and for the purpose of securing fresh seed of some varieties which had not recently been reproduced. The plots adjoining the Economic Garden and near the western entrance to the station grounds occupied a rich piece of land underdrained with tile the previous year, and thus rendered available for this purpose. The benefit derived from the tiling was very apparent. It rendered early sowing possible where, before draining, the piece was boggy until late in the spring, because of abundant seepage from the adjacent hillside. The wheat plots during the whole growing season were notably fine in appearance and attracted much attention from visitors. On the main field of the station grounds there were small plots of other cereals than wheat, and large plots of varieties especially desired for seed-distribution supplies for the coming winter. Enough hay was produced on other portions of the main field to sustain the station team during the year.

Orchard and Vineyard.—The old vineyard plot adjacent to the greenhouses, which has been maintained several years longer than otherwise desirable, for the special purpose of observation and experimentation upon the phylloxera, was cleared out during the spring of 1890, and the space thus secured was devoted to the extension of the olive plantation, which was made necessary because of the large accessions made to our list of varieties by direct importation from Italy and France, and by donations from other importers. These trees have made very satisfactory growth.

An irregular-shaped piece of ground adjoining the Economic Garden, from which eucalyptus trees were cut several years ago, was cleared of stumps, trenched deeply, and planted to resistant grape varieties, for which there was not sufficient space in the Economic Garden. This small vineyard has been neatly trellised with a strong post-and-wire

trellis, and offers excellent opportunity for growth with long canes, which most of these varieties require for fruiting. It prepares the way also for comparative experiments in long and short pruning of the same varieties; also, to secure more wood for cuttings for outlying stations and for distribution.

Our standard orchard of deciduous fruit trees has been maintained in the same manner as in previous years, and extended by the introduction of many new varieties, both of local and distant origin. The apricot collection has been thus extended, extra space being secured by rooting up a portion of the later-ripening peach and nectarine varieties, for which this location is not suited.

The underdrainage of the orchards, to which allusion has been made in previous reports, has continued to yield satisfactory results. The surplus water is quickly removed from portions which were previously so boggy during the winter that cultivation could not be pursued at the proper time. Since the drainage, the orchard area is nearly uniform in its moisture conditions, and can be freely worked at desirable times.

Garden and Nursery.—The Garden of Economic Plants has been continued upon its former plan, and through other provision for a portion of the grape collection and for purely botanical growths, more space has been secured for the extension of other features of the collections. The growth of many exotics in the garden has made them specially interesting and attractive, and furnishes data for many allusions in other portions of this report. The same is true of the results attained with grasses and forage plants, reported upon elsewhere. Each year the garden, by its command of popular interest and demonstration of the adaptation of plants from distant countries to this climate, is more fully realizing the purposes had in view at its establishment.

The needs of the Department of Botany are being met for the present by the establishment of a botanic garden on another portion of the station grounds. It has been laid off with suitable plots and walks, and is being progressively planted under the direction of the Associate Professor of Botany.

The old nursery ground adjacent to the greenhouses being too small to meet the growing demand for propagation for outlying culture stations and for distribution, a new piece of land in the northeast corner of the main field was plowed, subsoiled, and laid off for nursery work. A part of the space was given to the multiplication of new Italian and French grape varieties, mentioned elsewhere, to the propagation of deciduous fruit trees, and to other growths needed for distribution. The site is well suited for the purpose, except in the lack of water supply, which can be secured later.

Propagating Houses.—The re-painting and glazing of the old propagating houses has extended their period of usefulness somewhat, but the fact of their insufficiency for the present work of the station is more and more clear. Not only is it impossible to keep up with the demand for propagation under glass, but, as has been stated in earlier reports, valuable plants are being continually sacrificed because their growth endangers the low, insecure roofs under which they expand. There is seriously needed proper greenhouse accommodations. Many plants, notably the palms, become interesting and valuable as they attain size, and yet just at this point we are obliged to throw them out. There is, fortunately, reason to expect that a remedy for this deplorable state of affairs will

soon be provided in the form of a plant house, for which provision has been made from the General Fund.

A lath house has been constructed sixteen and one half by twenty and one half feet, with a height of eight feet eight inches. This is strongly made of redwood frame, with battens instead of lath, which gives the structure promise of long usefulness.

The propagation during the year has been chiefly in the line of economic plants for trial and distribution, as heretofore. With increased accommodation we hope to do something more to interest the planter for home adornment.

Arboretums.—The hillside arboretums on the eastern boundaries of the University grounds have been given due attention, and the results are fairly satisfactory, considering the difficulties of the arid situation. Landslides of the heavy winter of 1890 were obliterated by grading; the roads were cleared and repaired, and the arboretums made more accessible. Additional plantings included English oaks and Monterey cypress. The oaks have done moderately well.

The pinetum on the west side of the grounds has been improved by judicious thinning out.

Roads and Walks.—The roads and walks throughout the station grounds have been improved by grading, the construction of culverts, and by graveling. They are now in better shape than formerly, and by better arrangements for drainage, which have been made, can be easily kept in fair condition.

Manures.—The application of considerable quantities of manure is necessary for the satisfactory growth of orchard trees and in gardening operations. Supplies are now being secured from the village barnyards without cost—the hauling being done by the station team.

THE BOTANIC GARDEN.

By Edward Lee Greene.

The botanical garden has always and everywhere been recognized as a most important adjunct to a thorough and efficient course of instruction in the knowledge of plant life in general. The Garden of Economic Plants, long ago established at Berkeley by Professor Hilgard, is to be accounted an excellent beginning in this direction, and is doing good service. Toward the close of the current year a special apportionment of money from the College Aid Fund for the purpose has enabled us to take initiative steps in the direction of a more general botanical garden; and it is proposed, first of all, to form a living collection or garden of the native trees, shrubs, and herbaceous plants of the State of California; gathering in at the same time, as rapidly as our limited facilities will permit, those of our neighboring States on the Pacific Coast. No region of the world has a more interesting or varied native vegetation than this coast; and scarcely more than a beginning has been made at the scientific study of it as a whole. The moderate climate of Berkeley, exempt from all extremes of heat and cold, humidity and drought, is just that which must prove adapted to the growing of the greatest variety of plants in the open air, and without irrigation. During the few months which have elapsed since the movement became authorized, we

have been procuring from collectors in several parts of the State such seeds as they could obtain, and have received several valuable invoices of living plants and shrubs. Upwards of a hundred select species, chiefly from the southern counties, are already thriving on the small plot of ground specially allotted; and, although the season for seed and collecting in the various mountain districts is not yet past, we are in possession of seed packets to the number of six hundred species and more. It is therefore confidently expected that the next growing season will enable the Station to exhibit an interesting garden of native plants from many and divers localities within the State, arranged systematically, and inviting the studies of the systematist and economist alike.

The prospective new plant house, to be constructed under the supervision of Professor Hilgard, will furnish a welcome and most important accessory to the work undertaken, as giving the means of growing the more curious and instructive of tropical plants, along with those of economic value.

OLIVE CULTURE AND OLIVE OIL.

OBSERVATIONS ON OLIVE VARIETIES.

By W. G. KLEE.

(*Experiment Station Bulletin No. 85.*)

[The increasing prominence of olive culture in this State gives importance to all light that can be thrown upon the subject; the more so as the slow growth of the tree renders mistakes made in the selection of varieties both costly and difficult of rectification. It is therefore the intention of the Station to subject both the growing trees and the fruit and its products to the most thorough comparative observation and investigation as quickly as the material shall be obtainable. In the meantime the observations of Mr. Klee (recorded below) appear of sufficient practical importance to justify their publication at this time.

It is evident that, both with respect to the production of oil and that of pickled olives, the proportion of kernel to meat is a matter of no mean importance, when we see, as is shown below, that this proportion varies all the way from 8 to over 34 per cent. Some have the impression that the oil of the kernel, or pit, forms a considerable proportion of the product, but the investigation of this point, made by Mr. L. Paparelli, upon the common olive of central Italy, showed this proportion to be as one to thirty, while in the Mission olive, noted for the rarity of sound kernels, the proportion was found, by Mr. Ad. Sommer, of the University, to be as one to one hundred and sixty-two; hence, to the oil-maker, as well as to the consumer of pickled fruit, the data given will be of some interest.—E. W. HILGARD.]

The following records and table show the growth of a number of varieties of olives as the result of several years' observations, and it is hoped will add to our knowledge of some of the numerous varieties now cultivated in this State. This is, of course, only the beginning of observations which will be continued for years to come. Nearly all the varieties enumerated are now growing at the four different experiment stations, viz.: Berkeley, Paso Robles, Jackson, and Tulare, and we shall thus have a good opportunity to test their respective value in these four

distinct sections. Those at Berkeley were planted five years ago, while those at the other stations were set out only a year ago (1889), and thus afford but few data of value.

The observations of the varieties growing on the grounds of the California Nursery Company, Niles, and at Fancher Creek Nursery, Fresno, I have personally had the opportunity to make, through the courtesy of their respective managers, Mr. John Rock and G. C. Roeding, who, as well as Mr. Juan Gallegos, of Mission San José, kindly allowed me to take specimens for identification.

In the text following the table only a description of the fruit is given, since the foliage varies so much, as between old and young trees, as to make it difficult of use as a distinctive mark.

In "Series I," the varieties are arranged in accordance with the proportion of the pit to the pulp, by bulk, as shown in the last column of the small table preceding their discussion. The measurement given represents, of course, the average of a greater or less number, made on normal fruit. We can thus obtain a fair idea of the actual bulk of pulp contained in a gallon of the fruit. This, it is true, is only one of the factors that determine the value of the olive. The actual yield of oil, and the quality of the latter, remain to be determined hereafter, but the table, as it is, will serve for purposes of investigation, and is certainly of practical interest.

TABULATED STATEMENT OF GROWTH AND BEARING OF VARIOUS OLIVE VARIETIES IN BERKELEY, AND OBSERVATIONS IN OTHER LOCALITIES.

Name and Age When Planted.	Cuttings, or Grafted Trees.	Diameter of Stem.	Diameter of Crown.	Height.	Observations of Habit of Growth and Bearing in Berkeley.	Observations in Other Localities.
Regalis— April, 1885; two years old.	Grafted on Redding Picholine.	One inch.	Very small.	5 feet.	This specimen is in a rather unfavorable spot; growth poor.	Bearing well at Niles, as well as in Fresno.
Polymorpha— April, 1885; two years old.	Grafted on Redding Picholine.	One inch.			Slow grower here; no sign of fruit yet.	Bearing fairly well at Niles; at Fresno, little fruit yet.
Macrocarpa— April, 1885; two years old.	Grafted on Redding Picholine.				Seemingly a good grower; no sign of fruiting yet.	At Niles, bearing fairly well; at Fresno, a tree stunted by close pruning has very large fruit.
Columbella— April, 1885; two years old.	Grafted on Redding Picholine.	Very small; not measured.			Lacks vigor; in this instance most likely due to poor union of graft.	Bearing well both at Niles and Fresno.
Nevadillo blanco— April, 1885; one year old.	Small rooted cuttings.	No. 1, 3 inches. No. 2, 2⅞ inches. No. 3, 2¾ inches. No. 4, 2½ inches. No. 5, 2 inches. No. 6, 1½ inches. No. 7, 1⅛ inches. No. 8, 2½ inches.	9 feet. 8–9 feet. 8 feet. 7 feet. 7 feet. 7 feet. 7 feet. 7 feet.	10 feet. 9 feet. 9 feet. 9 feet. 8 feet. 8 feet. 8 feet. 9 feet.	A very strong grower; light silvery foliage; drooping habit; has not bloomed yet.	One small tree bearing well at Niles; at Mission San José a number of trees bearing well; also at Fresno. Seemed more tender than some others, and suffered from frost at Experiment Station, Jackson, in January, 1890.
Manzanillo No. 2 (true)— April, 1885; one year old.	Small rooted cuttings.	No. 1, 1½ inches. No. 2, 2½ inches.	5 feet.	6 feet. 6 feet.	Upright, moderate grower, sparse foliage, shows tendency to be straggling. Several trees showed blossoms last spring; none set yet.	Four-year old tree bearing a few fruits at Niles; at Fresno, trees from the imported truncheons are bearing well; fruit large. Seems very hardy as regards frost.
April, 1886.	Six cuttings made from pieces of truncheons average:	One inch.	4 feet.	6 feet.		
Pendulina— April, 1885; two years old.	Grafted on Redding Picholine.	No. 1, 1½ inches. No. 2, 2 inches.	6 feet. 7 feet.	8 feet. 8 feet.	Strong grower, with decidedly drooping habit; bloomed considerably, but set only a few fruits.	Shows tendency to coulure, but bears well nevertheless at Niles; at Fresno, the setting was poor, owing to coulure.

Oblonga (Rock's)—						Moderate grower; bearing early and well; noticed at Niles, at Auburn, at Saratoga, Santa Clara County, and at Fresno.
Rubra— April, 1885; two years old.	Grafted on Redding Picholine.	One and one half inches.	5 feet.	6 feet.	Showed blossoms last year, but did not set; this specimen is affected by neighboring trees.	A fair upright grower; bears early and abundantly. Observed at San José, Niles, Fresno, and Riverside, San Bernardino County.
Præcox— Two years old; 1885.	Grafted on Redding Picholine.	One and one half inches.	5 feet.	6 feet.	Fair grower; showed blossoms this year, but did not set.	Bearing well both at Fresno and Niles.
Atro-rubens— April, 1885; two years old.	Grafted on Redding.	Very poor specimen, probably due to imperfect union of the graft.				At Niles coulure seemed to be the cause of poor setting.
Uvaria— April, 1885; two years old.	Grafted on Redding Picholine.	Original specimen died; was replaced last year.				Bears very abundantly, both at Niles and at Fresno.
Atro-violacea— April, 1885.	Grafted on Redding Picholine.	One and one half inches.	6 feet.	7 feet.	Fair grower; no sign of fruiting this year.	Bearing well at Niles; at Fresno, fair yield.
"*Redding Picholine*"— April, 1885; one year old.	Small rooted cuttings.	No. 1, 2½ inches. No. 2, 2¼ inches. No. 3, 1¾ inches. No. 4, 2¼ inches. No. 5, 1¾ inches. No. 6, 2½ inches.	8 feet. 7 feet. 6 feet. 6 feet. 5 feet. 6 feet.	9 feet. 8 feet. 7 feet. 7 feet. 6½ feet. 7 feet.	Fair upright grower; some trees blossomed considerably, but nearly all dropped off.	Bearing well at Niles, and at Fresno as well as in any part of the State.
Razzo— April, 1888.	Small rooted cutting.			4–5 feet.	A thrifty grower.	
Correggiolo— April, 1888; three years old.	Small rooted cutting.			5 feet.	A thrifty grower.	

NOTE.—Observations at Fresno refer to Fancher Creek Nursery, Fresno. Observations for Niles refer to California Nursery Company's grounds, Niles.

Olive Varieties Ranked According to Per Cent of Pit.

Variety of Olive.	Dimensions of Fruit, in 16ths of an Inch.				Pit, per cent by Bulk.
	Whole Fruit.		Pit.		
	Length.	Width.	Length.	Width.	
Regalis	17	13	9	5	7.8
Manzanillo No. 1	16	13	9	5	8.3
Nevadillo blanco	16	10	10	4	10.0
Pendulina	12	9	7	4	11.5
Columbella	14	11	8	5	11.8
Mission	16	10	10	5	15.6
Polymorpha	19	12	12	6	15.8
Rubra	12	8	8	4	16.7
Rock's Oblonga	15	8	11	4	18.3
Mignolo*	9	7	8	4	29.0
Redding Picholine	8	6	6	4	33.3
Uvaria	13	9	10	6	34.2

Series I.

Regalis.—Imported by John Rock from France. Almost perfectly rounded-oval; when ripe, dark purple or black; large, one and one sixteenth inches long by thirteen sixteenths of an inch in thickness; flesh firm; pit nine sixteenths of an inch by five sixteenths of an inch, generally straight, square at the base, pointed at the apex. Ripens slightly ahead of the broad-leaved Mission variety.

Manzanillo No. 1.—Imported by F. Pohndorf from Spain, and grown by Juan Gallegos, Esq., at Mission San José; large, one inch long by thirteen sixteenths of an inch in thickness; regular rounded-oval; pit straight, strongly pointed at the apex, nine sixteenths of an inch long, five sixteenths of an inch thick. Ripens early—several weeks earlier than the broad-leaved Mission. In many respects this resembles the *Sevillano Gordal*, or queen olive of Spain, more than any variety I have examined in this State. The fruit grows on long stems, and in a windy place would be liable to fall. The pulp parts readily with its bitterness, and is exceedingly rich when pickled.

Polymorpha.—Imported by John Rock from France; very large, ovate, oblique and pointed; one and three sixteenths inches long by twelve sixteenths of an inch thick; pit twelve sixteenths of an inch by six sixteenths of an inch in thickness, square at the base, strongly pointed at the apex; flesh firm. Time of ripening falls much like the broad-leaved Mission; fruit grows on strong stems in clusters of two or three.

Macrocarpa.—Very much like above; we have not had specimens enough to make out a distinction.

Columbella.—Imported by John Rock from France. General form broadly oval, fourteen sixteenths of an inch long and eleven sixteenths of an inch thick; very even in size; remarkable for the peculiar pale yellow color which all the fruit assumes before turning fully ripe and becoming dark purple; pit small, eight sixteenths of an inch long by five sixteenths of an inch in thickness; straight and sharp pointed. The pulp seems to part with the bitterness slowly, but when extracted, the flavor is very rich. Ripens late—later than the broad-leaved Mission.

* Measurements taken from Caruso's cut of this variety, for the sake of comparison.

Nevadillo Blanco.—Imported by F. Pohndorf from Spain. Oval, slightly oblique, pointed, one inch long by ten sixteenths of an inch thick, resembling somewhat a broad-leaved Mission, but is generally more elongated in proportion to its diameter than the latter. Pit small, curved, and generally pointed at both ends, ten sixteenths of an inch long by four sixteenths of an inch thick. The fruit is borne in clusters of three to five. Its time of ripening does not appear to be much earlier than the broad-leaved Mission.

This variety has been propagated considerably at the nursery of the Experiment Station, and has been scattered widely by distribution from here during the last two or three years. The reports received from these trees go to show that it is a remarkably robust and fast grower in the hottest as well as in the coolest portion of the State. Should this olive prove a good and constant bearer, as there is every reason to believe, it will prove a valuable addition to varieties of olives. Its time of ripening may be an objection to its planting in localities near the coast, subject to early frosts. Reports indicate that it is more tender to frost than certain other varieties, a fact which is undoubtedly due to its almost constant growth, and shows that moist soil should be avoided for this variety, perhaps, more than for any other.

Manzanillo No. 2.—Imported by F. Pohndorf from Spain. As the name ("small apple") indicates, this variety is of an unusual shape, only one, the Dalmatian (Hervaza), resembling it. It is nearly round, with a pit of rounded-oval shape, rather squarely cut off at the base. As the specimens were few and not quite fully grown, measurements are not given. This variety ripens early—several weeks earlier than the broad-leaved Mission olive; the fruit grows generally singly on long stems.

This variety, which I have seen fruiting in Fancher Creek Nursery, near Fresno, has the same straggling and sparse growth which characterizes the variety I have designated as Manzanillo No. 1. It is supposed to be this variety (No. 2) which has been disseminated from the Station, although as Mr. Gallegos has received the other variety (No. 1) from the same source as we, under the name of Manzanillo, the two may have been mixed, the wood and foliage being much alike.

Pendulina.—Imported by John Rock from France. This variety is of an even-oval shape, rounded at both ends, quite variable in size, many fruits remaining small and undeveloped; twelve sixteenths of an inch long and nine sixteenths of an inch thick; pit seven sixteenths of an inch long and four sixteenths of an inch thick, exclusive of the small, sharp points often found at both ends. The fruit grows in clusters of from two to five; the pulp parts very readily with its bitterness. This variety must not be confounded with the Pendoulier, a variety imported by Mr. Albert Montpellier, and fruited at his place at Vacaville. The latter variety is somewhat larger and more of an ovate shape.

Oblonga.—Imported by John Rock from France. An olive of a peculiar club-like shape, being narrow at the stem end, broad at the point, rounded and strongly oblique; fifteen sixteenths of an inch long and eight sixteenths of an inch in thickness; pit curved, eleven sixteenths of an inch long by four sixteenths of an inch in thickness; generally pointed at both ends. The pulp loses its bitterness comparatively quickly in pickling. This olive ripens quite early—at least two or three weeks earlier than the broad-leaved Mission; color dark purple.

Coutance, as well as several other authors on the olive, gives the name of Picholine as synonymous of *Oblonga*. As a matter of fact, the olive imported by Mr. Rock under the name of *Oblonga* is a totally different-looking olive from the variety described and pictured in the Annals of the School of Montpellier (and translated in Mr. Lelong's pamphlet on olive varieties) as the Picholine. Rock's *Oblonga* seems to me to belong in the neighborhood of the *Lucques*.

Common or *Broad-Leaved Mission Olive*.—The variety of olive most generally known as the Mission; thirteen sixteenths of an inch long by ten sixteenths of an inch thick; ovate, oblique—sometimes very much so. The pit straight or slightly curved, ten sixteenths of an inch long and five sixteenths of an inch thick; fruit very variable in size, growing singly or in clusters of two or three, or even five. Time of ripening, late, in the coast region, sometimes not before February, but generally in December; in warmer localities, in November.

Rubra or *Caillon*.—Imported by John Rock from France. Ovate, slightly oblique, looks a good deal like a small Mission olive; twelve sixteenths of an inch long and eight sixteenths of an inch thick; pit straight, pointed, eight sixteenths of an inch long and four sixteenths of an inch thick. This variety is an early one, and ripened three or four weeks earlier than the common Mission variety; is of a jet black when ripe. This variety, it appears, has been imported by several different persons; among others Mr. Bliss, of Riverside, on whose place I saw trees of it three years ago, heavily laden with fruit.

Uvaria.—Imported by John Rock from France. Oval, regular, and rounded on both ends; thirteen sixteenths of an inch long and nine sixteenths of an inch in thickness; pit straight, heavy, ten sixteenths of an inch in length and six sixteenths of an inch in thickness. Late; later than the common Mission olive. Color dark purple or black when ripe. The name "grape-like," is well chosen, the fruit growing in clusters, as many as seven together, and in shape themselves resembling the grape.

"*Redding Picholine*."—Imported by the late B. B. Redding. A perfect oval in shape, eight sixteenths of an inch long and six sixteenths of an inch thick. Ripens early, several weeks earlier than the common Mission; dark purple or black when ripe. In pickling, the pulp loses the bitterness quickly, the fruit being very pleasant. This variety has been propagated extensively in the State, and until fruiting, was supposed to be a large "pickling" variety; then, not having an adequate description of the Picholine at hand, it was believed for a number of years to be rightly named after all; various authors designated the Picholine as a small olive. Two years ago, in the Annals of the School of Montpellier, France, there appeared a description of the Picholine as known there. Mr. B. M. Lelong had this promptly translated for his report, and deserves credit for having thus settled that the variety of Redding's introduction is not the French Picholine. The Redding Picholine, which name has naturally suggested itself for want of a better, has produced oil of good quality. In proportion of pulp to pit it is but slightly inferior to the Italian *Mignolo* or *Gremignolo*, judging from Caruso's description. The only record in regard to the yield of oil I have had occasion to examine into was made several years ago by Mr. L. A. Gould, then of Auburn, who, from two thousand five hundred pounds of olives, chiefly Picholine, only obtained twenty-four gallons of

oil, making a percentage of 7.04. The Italian *Mignolo*, in Caruso's work, measures only nine sixteenths of an inch, with a thickness of seven sixteenths of an inch; the pit being large, eight sixteenths of an inch long by four sixteenths of an inch thick, which places it very near the Redding Picholine. The strong recommendation of this olive by the Italian authorities, for foggy regions, makes this variety, nevertheless, interesting and worthy of trial in such places.

Series II.

Of these no measurements have been made, but some record of growth and general behavior is given in the preceding table.

Atro-rubens.—Imported by John Rock. According to Coutance, synonymous with *Salierne* or *Sayerne*; of a violet-black color, covered with bluish bloom; rounded at the base, pointed at the top; cultivated throughout Languedoc; valuable for oil.

Olea atro-violacea.—Imported by John Rock from France. A good-sized olive, making oil of first quality, according to soil.

Razzo or *Frantojano.*—Imported by Judge J. R. Logan, of Santa Cruz. An olive from the Lucca district, in Italy; oval, medium size or below; it yields, in its native country, a very fine oil.

Correggiolo, or *Grossajo*, or *Frantojo.*—Imported by Judge J. R. Logan, of Santa Cruz. An olive from the Lucca and Pisa districts, in Italy, furnishing some of the finest oil; fruit medium-sized; of inverted-oval (obovate) shape, narrower at the stem end, broader toward the point.

Amellou, or *Olea amygdalina.*—Imported by Mr. C. A. Wetmore. A large, valuable variety, both for oil and pickles.

Lucque, or *Olea adorata.*—Also imported by Mr. Wetmore. A peculiar, almond-shaped olive; one of the richest for pickles.

Mission Varieties.—A number of years ago my attention was called to the fact that there existed several distinct forms or varieties of "Mission" olives. We are propagating now three apparently quite distinct kinds: (*a*) Broad-leaved or common Mission (already described); (*b*) Narrow-leaved Mission; a variety received originally from L. A. Gould, of Auburn, described as having a somewhat larger fruit than the common Mission, and a more straggling habit; (*c*) *Early Mission*, procured from A. A. Wheeler. It is of the Mission type, but ripens at the end of October in Alameda County. At Pomona my attention was called to an old, large tree, growing on the ground of Rev. Mr. Loop, which, he stated, bore a large olive, ripening in October. Whether the two are identical or not I do not know.

Oblitza.—Obtained from Mr. George Ladd, of Atwater; imported by the late N. Milco from Dalmatia. This variety fruited at Atwater Station, and resembles somewhat the variety called Pendoulier, specimens of which are fruiting at the ranch of A. Montpellier, near Vacaville. Further examination is necessary to determine whether the two are identical.

Hervaza.—Obtained from the same source as the above. This variety much resembles the Manzanillo in shape, but the pit of the fruit is more squarely cut off than that of the latter. The trees of the two varieties are totally distinct. The *Manzanillo* has an upright, sparse growth, and dark-colored wood. The *Hervaza* is of drooping habit and the

wood is light-colored. Time of ripening of the two falls about the same at Atwater, viz., in the beginning of October.

UNIVERSITY SEEDLING OLIVES.

The seedling olives in the Berkeley experiment grounds have attracted the attention of horticulturists, not so much from any especial promise that they have yet shown as from the ease of their growth, which ought to persuade many others to try to raise a few seedlings. As reported in Bulletin No. 92, chemical tests were made in 1890–91 of the oil from two of the Berkeley seedlings, No. 2 and No. 10; No. 6 is also an olive that is worth further study, and perhaps two or three more of the seedlings have some value.

The history of the growth of these olives was written in 1890 by the late Waldemar G. Klee, former Inspector of Stations, and found among his papers. He says:

"In previous reports reference has been made to experiments with seedling olives at the Station, but as the subject is of considerable interest and importance, I will give the history of the seedlings. Seeds of different named varieties of olives, including *Præcox*, *Atro-violacea*, *Uvaria*, *Atro-rubens*, *Nigerrima*, and others, were received from John T. Doyle in April, 1880. The seed was imported from France. This lot of olives was planted in a well-prepared seed-bed. Before planting, the seeds had been soaked in an alkaline solution, one fourth of a pound to a gallon of water. Most of them sprouted the first year, although three failed to appear until the next year.

"The trees were left two years in the seed-bed, during which time they made little growth. In the spring of 1883 twenty trees, two of each kind, were transplanted to a permanent place in the grounds, in a row bordering on a road. The soil there is of a stiff character, and at one to two feet depth becomes very clayey. During the first year these trees received some water, but since then very little attention has been given them outside of breaking the surface of the soil around the trees for a distance of three feet. Their growth was slow; small cuttings were therefore taken, rooted under glass, and set out in the spring of 1885. These, in nearly every instance, have outgrown the stocks.

"In 1888 one of the trees showed some blossoms, but did not set. In the spring of 1889 several more trees produced an abundance of blossoms, but, with an exception of one tree raised from *Nigerrima*, they did not set. This, however, had quite a large number of olives, which were of considerable size, and indicated a comparatively early ripening. A few seedling trees were sent to the Santa Cruz Mountains, seven miles from Santa Cruz, and planted on very shallow land. One produced a few blossoms in 1888, and matured a few olives, which were, however, of rather minute size. In 1889 the tree bloomed very freely, but failed to set. The variety from which was raised both the tree at Santa Cruz and the variety to bloom first at Berkeley is *Præcox*. In habit it is a compact grower, and seems rather dwarfish in character.

"The appearance is against most of these seedlings, and does not favor the hope that they may be something really good. Most of them resemble the wild olive in manner of growth and leaf. Nevertheless, some of them are evidently going to produce a better fruit, and perhaps a hardy variety may be amongst them. The experiment is of interest as proving

how long it takes an olive to produce fruit from seed in this State, and it is seen that in this, as in many other instances, precocity is the rule. One of the trees fruited at eight years from the seed. A number of others bore at nine years from the seed. In a warmer part of the State a much earlier fruitage would have been obtained."

RIPENING, PICKING, ASSORTING, AND CONSERVATION OF OLIVES.*

By Louis Paparelli.

Ripening.

The ripening and picking of the olives affect very materially the olive oil industry, and therefore in gathering them their degree of maturity should be closely noted, for on that depends in a great measure the quantity and quality of oil that will be obtained.

The ripening of olives varies greatly according to the nature of the soil and of the climate, of the exposure of the plantation and of the tree; also, according to the variety cultivated and the kind of manure used.

In warm climates and under the influence of strong sunlight the olives ripen more quickly, and, in general, give a heavy tinted oil, rich in special aromatic matters. In cold climates, on the contrary, the ripening is retarded and the oils produced are lighter, clearer, and whiter. In moist or rainy climates the olive ripens very late, and the quantity of oil they give is less.

In poor, clayey soils the maturity is retarded and the yield of oil is small; in a fertile, calcareous soil, slightly moist, warm, and rich in phosphates, the ripening is generally normal and the yield much more abundant. The olive grower, in seeking to enrich his soil, should choose those manures which will hasten the maturity of his crop and, at the same time, increase its quantity and improve its quality.

Finally, the maturity will be early or late, according to the variety cultivated, and according to the northern or southern exposure of the tree or its branches; also, according to the form given to the tree in pruning, and to the amount of cultivation given to the soil.

In olive oil making, the maturity of the olive should be considered from an industrial standpoint, not from a physiological one; that is, the gathering of the olives should be governed by the quantity and quality of the oil that it is desired to produce.

The ripening of the olive is marked by four variations in the color of the skin: (1) From olive-green to lemon-yellow; (2) from lemon-yellow to red or purplish-red; (3) from purplish-red to wine-red; (4) from wine-red to a velvety black. Generally, under favorable conditions of soil and climate, the velvety-black color will mark the proper time for gathering the olives for industrial uses, though the ripening is physiologically continued for some time longer.

However, the exterior coloration of the olive is not an infallible sign of its ripeness, for there are modifications in this coloration and variations in its intensity dependent upon the different varieties cultivated. It should also be borne in mind that the velvety-black tint in olives grown in a cold climate does not represent the same degree of ripeness

* Paper read before the Fruit Growers Convention at Santa Cruz, November 21, 1890.

that the same tint does in olives grown in a warmer one; so that these, and other general considerations, though giving an approximate idea of when to gather the crop, must be supplemented by local experience, which alone can determine the exact time.

While noting the color of the outside of the olive, it must also be cut, and the pulp examined, to see whether it is whitish or colored; observing, also, the quantity of the water and the droplets of oil it contains. Note should also be taken of the stone, whether it is still white, or has become brown; and of the taste of the juice, whether sweet or bitter, and so on.

If, in the extraction of the oil, high quality is the object in view, the olives must be gathered when they show the black-velvety color in cold climates; but, as in warm climates this color corresponds to a certain degree of overripeness, the fruit must be gathered while still yellowish, and hardly commencing to redden, in order to obtain an oil of equal delicacy.

If, on the contrary, the oil-maker cares little about the high quality of his oil, but aims principally at quantity, he can gather his olives at their complete maturity. He ought, however, never to leave them on the trees longer than this, for they will gain nothing in oil, and will run the risk of being spoiled by climatic causes, or by birds and insects; and in this case the oil obtained will be of even inferior quality to that intended, and it will keep poorly.

Summarily, then, it may be said that olives gathered a little *before* their perfect maturity yield an oil of superior delicacy and fruity taste; those gathered a month later give an oil of ordinary quality; while those gathered very late give a very inferior oil, which can only be used in the manufacture of soap, or for illuminating or lubricating purposes, etc.

The oils furnished by fruit of different degrees of maturity may be characterized thus: Very unripe olives furnish a bitter oil; those which are nearly ripe give an oil which has a fruity taste, and, everything considered, is better than any of the others; olives which are completely ripe produce an oil with a strong flavor, which is hardly agreeable, and is subject to become rancid; overripe olives yield a very greasy, thick oil, which is very difficult to keep from spoiling.

Methods of Gathering the Olives.

The ripening of the olives not being uniform on all trees, and varying even on the same tree, two or three separate pickings are generally made. The picking should be done in good weather, when the atmosphere is clear and dry, and when the soil is not damp from previous rains.

Four ways of gathering the olives are practiced: (1) Picking up those which have fallen on the ground; (2) picking by hand; (3) beating the trees; (4) shaking the branches. The falling of the olives may be caused by climatic influences, or by animals, or finally by overripeness. These fallen olives are gathered and kept separate, to be used in the making of oil of inferior quality.

Hand-picking is the method most to be recommended, as it does not injure the fruit in any way; and in a country like California, where the olive trees have not yet arrived at any great height, it should be prac-

ticed exclusively. Hand-baskets are the best receptacle to use in this mode of gathering.

Beating the trees with a pole or stick is the worst possible way of harvesting, and should only be practiced in exceptional cases, as it damages both the fruit and the tree, doing harm also to future crops.

Shaking the branches to make the olives fall, though less pernicious than beating the tree, is not to be recommended except in certain cases; that is, when, from the height of the tree or the extent of the branches, the olives grow out of reach of the workman's hand. As shaking the tree only detaches the spoilt or overripe fruit, it cannot be considered as a rational mode of harvesting.

The conclusion is that it is absolutely necessary to pick by hand if we wish to avoid all danger of injuring the quality of the oil, or of lessening the future production of the tree. Beating and shaking should be limited to those exceptional cases where the olives cannot be reached, by any available means, by the hand of the workman. It must not be forgotten to spread cloth sheets under the trees to save the olives from being still more damaged by falling directly on the bare soil.

Sorting.

The olives should be sorted to a certain extent during the gathering, and more completely and carefully afterwards at the oil mill. This selection is of great importance, as the fruit communicates to the oil all the good qualities and all the defects that it possesses when worked.

To transport the olives from the orchard to the oil mill, sacks should never be used, but some receptacle with unyielding sides, in order to protect the fruit from being bruised on the way. For this purpose baskets of different sizes and shapes are most suitable, but in case they cannot be procured, whatever is used must dry easily, and not be too porous or absorbent, like soft wood. The handling of the olives in filling and emptying the baskets should be done very carefully, in order not to break the skin; for in that case, the pulp being exposed to atmospheric agencies, fermentation is likely to set in and extend to the rest, rendering it impossible to preserve them for the time desired. Oil made from such fruit will not only be inferior from the beginning, but will very quickly acquire a very disagreeable, rancid taste.

The object in selecting is to separate the fruit into four different qualities: (1) The good olives; (2) the dry or frost-bitten ones; (3) those which have been broken, crushed, or in any way damaged in gathering; (4) the spoiled olives. It is hardly necessary to say that in sorting over, all leaves, twigs, etc., must be picked out.

It may be objected that to put all these details in practice would entail too great an expenditure of time and money; but when we consider the much greater price for which superfine oils can be sold, and the loss there will be in making only one grade of oil from the olives of different qualities, the practice of sorting will be found to be an economy. It can readily be done by women and children. Sorting by hand alone can only be practiced on a small scale, but by the use of an appropriate apparatus, moved by some motive power, large quantities can very quickly be sorted. This apparatus does not make a very complete selection, but is a great saving, even if the separation has to be finished by hand. A good grader would do much of the work.

Conservation.

In a rational treatment of olives they ought to be kept as short a time as possible after picking; for to keep them for any length of time, in order to work them at one's convenience, is as little practicable as would be the keeping of a similar quantity of grapes to be crushed later. The principal end to be kept in view in the keeping of olives, is the prevention of all heating of the mass, that would cause fermentation; but as the time which elapses between the picking and the working should be as short as possible, the capacity of the oil mill should be proportionate to the size of the olive plantation. In this way the delays and losses which are so common in many oil factories will be avoided. Of course it is useless to attempt to preserve any but the olives picked by hand and in the very best condition; all others must be crushed immediately, as they cannot be preserved by any practical means.

The only good method of preservation is to make use of trays or shelves of willow or cane; all other methods offer insuperable objections. The trays are arranged on shelves in a cool and well ventilated room facing north. The thickness of the layer of olives on each tray ought to average about two inches and a half, and under no circumstances should it exceed four inches. Frequent observations of the temperature should be made on each layer, and if the temperature rises above 59 degrees Fahrenheit they had better be taken to the mill at once. In order to prevent any elevation of temperature, it is necessary to turn over the olives often and so cool them by aëration.

With regard to the quality of the oil, the keeping of the olives should be as brief as possible. It is always best to work them immediately, but as that is not generally possible, three or four days should be the limit. In this time the fruit loses a portion of its water of vegetation, which in a rainy season is doubtless of some advantage.

Even when all the conditions for the preservation of the olives are favorable they must not be kept too long, as the oil may lose, but will never gain, in quality. In conclusion, I may say that the oils of Nice and Lucca owe their reputation to the fact that there the olives are worked immediately after gathering, or are only kept for a short time, and with all the care demanded by a rational method of treatment.

PROPER FERTILIZATION FOR OLIVE TREES.*

By L. Paparelli.

Were we to believe, absolutely, certain authors, who have written that olives grow and bear on the most barren ground, and consequently that all manuring should be dispensed with, our olive culture and oil-making would be in great danger. But in general, intelligent growers possessing experience with other crops, will know that a completely barren soil would never suffice for the life of any plant, even the least exacting. It is not true, then, that the olive thrives in all soils, and that it prefers those of inferior quality. On the contrary, we may be sure that it is not at all advantageous for the farmer to reserve the most sterile lands for his olives; the trees will look badly, and the quantity of fruit reaped will always be extremely small; the oil extracted therefrom could not

* Published in the "California Fruit Grower," March 14, 1891.

be but very inferior in quality to that obtained from olives well cared for. The olive likes a permeable and moderately damp soil; permeable, so that it may spread and grow deep roots; rather damp, so that it may stand aridity and dryness. Finally, I must say that as the olive, like other plants, takes from the soil the ingredients necessary to its vegetation, it is important to replace those ingredients in the ground by fertilizers.

Chemical Composition of the Olive Tree.

Before speaking of the fertilizers that best suit the olive, let us glance at the chemical composition of its ashes, according to the analyses I have made, in order to know better what are the principal substances necessary to obtain a good growth and production. The *percentage of ashes* obtained for each one of the parts analyzed was as follows:

Analysis of the Olive Tree.

	Wood.		Leaves.	Fruit.
	Large Branches.	Small Branches.		
Percentage of ash	0.941	0.963	2.506	1.422
Water and organic matter	99.059	99.037	97.494	98.578
	100.000	100.000	100.000	100.000
Composition of the Ash.				
Potash	19.165	20.492	30.260	60.744
Soda	2.250	4.778	1.614	2.225
Lime	57.574	50.412	46.155	16.282
Magnesia	3.652	6.760	4.424	3.770
Oxide of iron	3.275	3.284	1.414	0.096
Phosphoric acid	11.684	12.437	10.470	8.334
Sulphuric acid	2.119	1.160	4.754	1.104
Silica	0.281	0.677	0.649	5.670
Chlorine	Trace.	Trace.	0.260	1.581

Some other determinations of the proportion of nitrogen contained in the different parts of the olive, gave the following figures:

Wood	Large branches	0.881 per cent.	As nitrogen.
	Small branches	0.897 per cent.	
Leaves		0.912 per cent.	
Fruit	Pulp	1.120 per cent.	As nitrogenous matter.
	Endocarp	1.062 per cent.	
	Kernel	13.891 per cent.	

What substances, then, should be found in the soil and manure, in order that the olive tree shall remain vigorous and productive?

From the above analyses we can clearly see that there is an abundance of potash in the wood, in the leaves, and especially in the fruit; also, we find a good quantity of lime and phosphoric acid. In general, the quantity of oil is in proportion to the potash; the more the olives contain of potash, the more they are rich in oil, which is, moreover, of a better quality.

The experience of many years has proved to the European olive growers that trees growing in calcareous lands are the richest in mineral matters, and give oil of the best quality; these olives are always richest in potash. The other ingredients are not considered so important, because the small quantity needed is always found in the soil. It

seems, also, that an excess of lime existing in the soil facilitates the assimilation of the potash by the plants; therefore, we may say that the olive needs a calcareous soil, rich especially in potash and also not deficient in phosphoric acid. Besides the ingredients mentioned, it is important to observe the large quantity of nitrogenous matters contained in the fruit, the kernels being richest in this respect. This fact is not only important in regard to the crop, but also to reproduction by seed. Without a sufficient supply of nitrogen the kernels would not be completely developed, and therefore the few plants that we should obtain from them would not be vigorous, and would not make fine trees, even after being grafted with good varieties.

From all that has been stated above, we see that potash, phosphoric acid, and nitrogen are the substances which should be brought back to the soil by fertilizers. The question should now be considered with regard to the special conditions of California soils, in order to determine the fertilizers which suit best the nature and the needs of the olive trees in this State.

Fertilizers.

From the investigations of Professor Hilgard,* we know that nearly all the soils of California may be considered as abundantly supplied with lime; almost the same can be said for the potash, while phosphoric acid is more sparingly represented. Nitrogen is also found in small quantities only, except in some localities where there is a certain amount of nitrate. According to calculations made from my analyses, it appears that a large, robust olive tree, well cared for, in a soil suited to its development, takes away yearly, in its growing and crop, the following proportions of the principal ingredients:

	Grams.	Pounds.
Potash	460	1.016
Nitrogen	908	2.006
Phosphoric acid	171	.458

Summarily, it may be said that California soils are naturally very well adapted to olive culture, provided we increase, by the use of manure, their proportion of nitrogen and phosphoric acid in localities where these ingredients are deficient. It is not necessary to use special potassic fertilizers, both because the general condition of those soils does not require them, and because, since special fertilizers are usually of very quick action, they would not suit the nature of the olive tree, which, growing slowly, needs fertilizers that act slowly and for a long time. Being so fortunate as to have good soils in this State, we should provide for maintaining their fertility; and in order to obtain constant success in olive culture, I would recommend the use of a compound fertilizer, more convenient to the olive growers than high-priced special fertilizers. A very good fertilizer may be prepared by making a compost of stable manure, leaves, and olive twigs, black waters obtained in pressing oil, vegetable ashes, especially those from the olive, a little sheep corral manure, or human feces, scraps of horn, bones, and offal from the slaughter-house, and wool and leather waste. We should also

* See Bulletin No. 88 on "The Use of Fertilizers in California," in another place.

never neglect the residue from the olives themselves, on account of valuable substances they contain, both in the natural state or as ashes. Oil cake, for example, contains 9.71 per cent of nitrogenous matters, and its ashes 8.94 per cent of potash and 9.45 per cent of phosphoric acid. All the substances mentioned, or as many of them as are at hand, must be well mixed together and well cured in the manure pit, adding also earth and leaf mold found in the neighborhood of the farm. The reason for curing the animal manure with so many other matters is to diminish its concentration, and so have a vegeto-animal fertilizer, which, in my opinion, best suits the olive tree placed in favorable conditions of climate and soil. Mineral or animal fertilizers, used alone, are not good for olives, while a vegeto-animal fertilizer serves not only to restore the olive tree, but also to maintain a certain moisture and coolness in the soil, which is very important in warm countries. It is necessary to neutralize the strong acidity of the black waters pressed in oil making, by means of lime in the proportion of one and one third ounces per gallon of water.

Time and Mode of Manuring Olive Trees.

I would say, first of all, that the olive tree planted in a soil which suits it, does not need much manuring, and that in order to obtain oil of a superior quality the manuring must never be abundant; because while abundant manuring gives a large crop, the quality of the oil resulting is inferior and difficult to keep. Growers must, however, have both quantity and quality in view. Manure must always be put in at a certain distance from the roots, otherwise these would be damaged instead of benefited. For level lands dig a shallow trench around the trunk at a distance varying according to the age and size of the trees. That trench should be nearly sixteen inches in depth, and distant from two feet to six and one half feet from the trunk. In order to aërate the layer of soil where the roots are, the trench should remain open for about forty days in case of compact soils, but only for fifteen days in case of light ones. After that time the bottom of the trench is covered with a thin layer of fine earth, and upon it is placed the well-cured manure. The trench is then filled with half of the earth excavated, and the rest is used when the soil around the trunk settles. For hill lands the manure is placed in a round hole made in the soil on the upper side of the tree, so that the water in filtering through the soil carries the nutritive juices into contact with the roots below. The quantity of the manure to be given varies with the age and condition of the tree, the nature of the soil and of the manure, and finally according to the methods of culture.

Of compost, prepared more or less as indicated above, we may give from forty to sixty pounds to each tree, supposing the conditions of soil and climate be favorable. But the grower should vary the quantity according to the special conditions of his location, and also according to his experience, if he has grown olives for several years. We must, moreover, maintain the equilibrium of vegetation by pruning proportionately to the quality of the soil or the quantity of the manure employed. If the manuring was abundant, little pruning ought to be given; if, on the contrary, the manuring was slight, pruning ought to be heavier. In this way the vegetative equilibrium is maintained and the production will not suffer. It is impossible to indicate precisely the time for

manuring. Autumn is the time for cold soils where manure will decompose very slowly, so that at the starting of vegetation the trees may find the nutritive ingredients ready for use. Spring is the proper time for warm, very permeable soils, or those subject to be washed by rain. If such soils were manured in autumn, very little nutriment would remain at the commencement of growth in spring. Annual manuring is, of course, the most rational, and should be calculated so as to replace, as nearly as possible, the ingredients withdrawn by the preceding crop.

Pickling Olives.

For the purpose of pickling, the olives must be picked while green, namely, one month or six weeks before maturity; the latter, of course, is variable, according to climate and variety cultivated. The olives should be picked by hand, early in the morning or late in the evening. It is necessary to select the best fruit only, rejecting especially that which is spoiled or imperfect, and also to free it from leaves and stems.

All the modes of preparation can be reduced to two—one using a lye of greater or less strength, the other pure water only. The lye treatment is as follows: The olives are placed in vats, where they are immersed in a solution of caustic soda (concentrated lye) of the strength of 6 degrees Baumé, equivalent to about four ounces per gallon. After some hours, when by several tests the fruit is shown to have been well cured by the lye, this solution is drawn off and replaced by soft water, which must be changed several times during three or four days, until it is completely clear. Then the olives are placed in kegs, with a brine consisting of one ounce of salt and thirteen ounces of water for each pound of olives, or a gallon of brine containing ten ounces of salt to ten pounds of olives.

The lye may also be made with one part of quicklime and six parts of fresh wood ashes, well sifted. After having been in this lye six hours the olives are taken out and placed in fresh water, where they will remain during eight days, being careful to renew the water every twenty-four hours. After this time the olives are placed in a brine of salt and water, as stated above. In this manner they are preserved very well. They will be in a condition to be used in from one to two months, according to taste.

To preserve olives without lye they are placed in a crock, or wooden vat, in which they are submerged in pure water, covered with lemon leaves, and a grated frame placed above them to keep them submerged. The olives will remain one month in this liquid, which must be changed every twenty-four hours. After this the fruit is placed in vats; in the bottom a layer of salt, then a layer of olives, then salt again, and so on, the proportion being twelve pounds of salt to one hundred pounds of olives. This being done, the olives remain in the vats forty-eight hours, and after that clean water is added and a layer of one inch of salt placed on top. One month after this treatment they can be used. The olives can also be improved by placing aromatic herbs, like fennel, pistachio, etc., among them after the first treatment.

The strength of the lye above mentioned is intended for average sizes of olives; for smaller or larger fruit, the proportion of lye must be diminished or increased, also in case of those varieties which lose the bitterness sooner or later. Experience alone must be the guide in this matter.

NOTES ON CALIFORNIA OLIVES; THEIR ADAPTATIONS AND OILS.

By L. PAPARELLI.

(*Experiment Station Bulletin No. 92.*)

In view of the constantly increasing importance olive culture is attaining in California, I commenced last October, under instructions from Professor Hilgard, a study of the different olive varieties cultivated in this State, and of the quantity and quality of the oil produced by each.

The time that could be given to this subject being limited by other duties, what I considered most important was the identification of the varieties, from which afterward were obtained small samples of fruit, and used for a chemical test as to the quantity of oil each contained, and, so far as feasible, its quality.

My observations were thus necessarily confined to the plantations at Berkeley, Niles, and Mission San José, more especially to that of the latter point, where maturity being earlier than in the other two localities, we were enabled to obtain samples sooner.

My first visit was made at the beginning of November, 1890, to the plantation of the California Nursery Company, at Niles, where Mr. John Rock, the President of the company, kindly showed me all the varieties cultivated, and gave me much information regarding the large collection of foreign varieties, well cared for but with only a light crop; partly, doubtless, on account of their imperfect acclimation. The maturity was very late; the variety Rubra alone was just beginning to change color. This backwardness was probably due principally to their growing on low ground, for other trees but a short distance away on high ground showed a more advanced degree of ripeness. This exemplifies the rule that, especially in cool climates, the plantation on high ground is better suited to olives, because they receive there more air, heat, and light, so much needed by these trees.

I remarked, also, some damage to the crop caused by a very strong wind, which had blown for several days. This damage was still greater at Mission San José and at Berkeley, where I think that not only the wind, but the dryness of the soil, had contributed much to the falling off of a large proportion of the fruit. In fact, the rain coming soon after benefited somewhat the fruit which remained shrunken on the tree, improving it in appearance and size.

My attention was then directed to the olive trees of Professor Hilgard, at Mission San José, and there I began the identification of the varieties, of which I could determine only twelve—others being too young or without fruit. According to my observations, these varieties may be arranged as follows:

According to the Time of Ripening.

1. Nevadillo blanco.
   Atro-violacea.
   Pendoulier.
   Pendulina.
2. Redding Picholine.
3. Manzanillo.
4. Mission.
5. Polymorpha.
   Oblonga.
   Regalis.
6. Columbella.
   Uvaria.

According to Productiveness.

1. Mission.
2. Nevadillo blanco.
   Columbella.
3. Uvaria.
   Atro-violacea.
   Redding Picholine.
   Oblonga.
   Regalis.
4. Pendoulier.
   Pendulina.
   Manzanillo.
   Polymorpha.

It must be remembered that, with the exception of the Mission olive, most of the trees are young, and therefore the amount of the crop may not correspond with what would be obtained with older trees, so these data must be taken with due allowance.

In the plantation of the University at Berkeley the succession of ripening was the same as at Mission San José, but the fruit matured, correspondingly, from one to four weeks later. The yield ranged from small to very small on all the trees, with the exception of the Nevadillo blanco and the Mission, which had a good crop. Some trees of the former are already about seven years old, and those of the latter are represented by two large and old specimens. All the other trees are from four to five years old.

The results obtained should, however, be taken only as a preliminary experiment, because the number of samples of the localities represented, and the special conditions of the fruit, were not such as to give completely decisive results. Next season the test will be arranged in such a manner as to work on numerous good and large samples from various localities in the State.

We are also indebted to Mr. Geo. C. Roeding for six larger samples, produced at the Fancher Creek Nursery at Fresno. The first samples received from Fresno consisted of five varieties, one of which (name unknown) had been picked November fourth. The others were the Pendulina, Nevadillo blanco, Manzanillo, Atro-violacea, while the sixth sample, of the Rubra, was picked on February 5, 1891. Their condition was as follows:

Pendulina.—In fair condition only; some fruit dried and beginning to spoil; maturity far advanced.

Nevadillo blanco.—In fair condition, but overripe.

Manzanillo.—In fair condition; some dried olives; generally overripe.

Atro-violacea.—In good condition and at the right degree of maturity for warm climates.

No name.—In fair condition and overripe. This olive resembles somewhat the Italian Cerasola, but is a little larger.

Rubra.—In very bad condition; damaged by frost; maturity at right degree for warm climates.

From Mission San José was received also a sample of Nevadillo blanco, gathered January 13, 1891. It was in rather good condition, but the maturity was a little passed.

Of all the above samples except the Rubra, oil was made by the usual and practical method, in order to have a small quantity for testing its character.

Observations on the Oils Obtained.

On March 13, 1891, I made the following observations on the oils obtained:

FROM FRESNO.

Atro-violacea.—Condition thickish, not clear; color yellowish brown; odor not pronounced; taste rather greasy and coarse. It seems to be slow in clearing. General quality fair.

Nevadillo blanco.—Condition fluid, clear, but not yet bright; color light golden; odor rather pronounced; taste a little greasy, otherwise agreeable and delicate. It clears rapidly. General quality fine.

Pendulina.—Condition thickish, not clear; color yellowish brown; odor pronounced; taste somewhat greasy but agreeable. It will take long to clear. General quality good.

Manzanillo.—Condition very fluid, bright, and transparent; color fine golden; odor

slightly suggestive of unsoundness; taste very slightly rancid, otherwise delicate. General quality a rather good oil, clearing quickly. This sample was very small, and it was impossible to keep it well.

No name.—Condition clear but not yet bright, rather fluid; color fine light golden; odor pronounced, but not altogether pleasant; taste slightly greasy and rank. General quality, a common oil, but clearing quickly.

FROM MISSION SAN JOSÉ.

Nevadillo blanco.—(This oil was made two months after those from Fresno.) Condition fluid and almost clear; color rather deep golden; odor of fresh olives; taste, oil too young for a close judgment, but promises to become a very fine sweet oil.

From the above observations it appears that olives from the country about Fresno, like those from warm countries generally, produce a thickish oil, deep tinted, inclined to be "greasy," and therefore not easy to keep. Moreover, when made in larger quantities, this oil will not clear as quickly as did our small samples. The Nevadillo blanco yields the best oil among the varieties from Fresno, but it is still inferior in quality to the same from Mission San José, which, although made two months later, promises to clear before or almost at the same time as the other one.

In order to remedy the defects that oils made from olives growing in warm climates are apt to have, the fruit ought to be gathered when still yellowish and only just beginning to change its color toward maturity. Such fruit would always produce an oil which, on account of its delicate taste, would have the same acceptance as that obtained in cooler climates. If the olive grower cares more for quantity than for quality, the olives should be gathered when black and still firm; but in no case should this degree of maturity be passed, because the oil from such fruit would be of inferior quality, and sometimes also the quantity would be diminished.

The following table shows the analytical results obtained by Assistant Colby from the different samples received at this laboratory. Column 1 shows the proportion by weight between pits and flesh in the fresh fruit. Column 2 shows the proportion in which pits and flesh may be made to contribute to the oil product when fully extracted. Column 3 gives the absolute percentage of oil contained in pits and flesh. Column 4 finally gives the result of the "iodine test," much relied upon for the purity of commercial oils, as hereinafter explained:

Partial Analysis of Some Samples of California Olives and Oils.

Variety.	Locality.	Date of Picking.	1 Proportion of Pits and Flesh in Fruits.		2 Percentage of Oil in Whole Fruit Yielded by		3 Percentage of Oil Contained in Fresh		4 Iodine Absorption.	
			Pits.	Flesh.	Pits.	Flesh.	Pits.	Flesh.	Oil from Pressing.	Oils Extracted by Carbon Bisulphide.
Manzanillo	Fresno	Nov. 4, '90	13.0	87.0	.53	19.23	4.1	22.1	80.2	76.5
Manzanillo	Berkeley	Jan. 30, '91	16.0	84.0	.51	21.38	3.2	25.45	----------	76.8
Pendulina	Fresno	Nov. 4, '90	14.8	85.2	1.04	17.40	7.0	20.5	82.6	77.7
No name	Fresno	Nov. 4, '90	17.6	82.4	.88	16.63	5.0	20.2	80.2	73.4
Atro-violacea	Fresno	Nov. 4, '90	23.7	76.3	1.19	13.78	5.0	18.1	83.2	80.7
Nevadillo blanco	Fresno	Nov. 4, '90	17.5	82.5	.16	12.02	6.6	22.0	84.5	86.6
Nevadillo blanco	Mission San José	Jan. 13, '91	24.0	76.0	1.06	23.94	4.4	31.5	86.5	72.5
Nevadillo blanco	Berkeley	Jan. 7, '91	25.0	75.0	1.05	22.72	4.2	30.3	----------	83.2
No. 10 in row	Berkeley	Jan. 7, '91	30.5	69.5	1.34	18.00	4.4	26.0	----------	80.3
No. 2 in row	Berkeley	Jan. 7, '91	36.5	63.5	----------	----------	----------	----------	----------	----------
Redding Picholine	Mission San José	Jan. 8, '91	29.0	71.0	1.88	21.87	6.5	30.8	----------	73.5
Mission	Mission San José	Jan. 8, '91	23.5	76.5	.94	19.07	4.0	24.9	----------	81.0
Rubra	Fresno	Feb. 5, '91	19.5	80.5	.80	17.69	4.1	21.97	----------	74.2

Proportion of Pit to Flesh.

The first column, exhibiting the proportion of pit and flesh contained in the fruit of the different varieties, shows a maximum of 87 per cent of flesh in the Manzanillo from Fresno, and a minimum of 63.5 per cent in No. 2 (seedling) from Berkeley. Conversely, the percentages of pits were 13 for the former and 36.5 for the latter. Between the Manzanillo from Fresno and that from Berkeley there is a difference of 3 per cent, both in pit and flesh; this is doubtless due to the growth of the former in irrigated lands.

The same can be said for the differences existing between the Nevadillo from Fresno and that from Berkeley and Mission San José. Summarily, the varieties represented could be arranged as follows in regard to smallness of pit and largest amount of flesh: 1, Manzanillo; 2, Pendulina; 3, Nevadillo blanco; 4, no name (Cerasola?); 5, Rubra; 6, Mission; 7, Atro-violacea; 8, Redding Picholine; 9, No. 2 (seedling).

These determinations, which will be continued next season on all obtainable varieties, are very important, because they show especially which kinds are most suitable for pickling purposes, for which the finest and largest olives with the smallest pits are required.

Quantity of Oil.

The next determinations were made with the object of ascertaining the quantity of oil contained in the different varieties.

Of all those represented in the above table, only the Atro-violacea from Fresno and those from Berkeley showed exactly the right degree of maturity for oil-making; hence, the results obtained cannot be taken as representing exactly the respective practical values of the several kinds. However, with the exception of the Redding Picholine from Mission San José, the maturity of which was very far advanced, the other varieties give results which may be considered approximate.

From these determinations, taking into consideration the degree of maturity of the olives, it appears that the Nevadillo blanco from Berkeley and Mission San José contains more oil than the same from Fresno; while in the latter locality the Manzanillo has produced a little more oil than the Nevadillo, but the Manzanillo from Berkeley contains more oil than that from Fresno.

The minimum of oil product is shown by the Atro-violacea from Fresno, which was the best conditioned sample received from that locality.

It is extremely probable, therefore, that these consistent differences between the Fresno olives and those from the other localities are mainly due to the growth of the former on flat and heavily irrigated ground, tending to produce watery fruit with relatively little oil, particularly where bottom water lies near the surface.

With respect to the *quantity of oil* contained in them, these varieties can, therefore, according to these tests, be arranged as follows:

For Fresno.—1, Manzanillo; 2, Nevadillo blanco; 3, Rubra; 4, Pendulina; 5, no name (Cerasola?); 6, Atro-violacea.

For Mission San José.—1, Nevadillo blanco; 2, Mission. The Redding Picholine cannot be taken into consideration on account of its very advanced maturity.

For Berkeley.—1, Nevadillo blanco; 2, Manzanillo; 3, No. 10 seedling.

If we consider the quantity of oil that the *pit* may yield, we find the largest percentage in the Pendulina and the smallest in the Manzanillo, both from Fresno; and, glancing at the oil yield of the pits of the other varieties, we may conclude that it will be a more or less important consideration, according to the purposes that the oil-maker has in view, or according to the special conditions of his locality.

Quality of Oil.

According to European experience, the oil-maker who intends to produce oil of the highest quality must avoid, in its extraction, the grinding of the pits. The kernel contains an oil of inferior quality, which becomes rancid quickly and will deteriorate the fine oil from the pulp. An exception may exist in the case of varieties which, like the Mission, have abortive kernels.

Mr. Sommer, formerly Assistant in the Chemical Department of the University, reports that in April, 1885, he had the opportunity of working a small amount of Mission olives, and found that only 2.4 per cent of the pits contained plump and well developed seeds. The others contained either no seed or an imperfect one. All of the seeds, good and bad, were ground to a pulp in a mortar, and extracted with ether. The proportion of seed oil to pulp oil was thus found to be as 1 to 162, showing that in making oil from the Mission olive no good purpose is subserved by crushing the pits at all if it can be avoided.

The crushing of the pits may, of course, be avoided by the use of adjustable crushers, which crush the pulp while allowing the pit to pass intact.

In this manner oil of very high quality is obtained. Practically, the very small quantity of oil yielded by the pits may be neglected, because this loss will be largely repaid by the higher price at which superfine oil can be sold. This loss, moreover, concerns only the first pressing, for the pomace can then be passed again through the mill in order to grind the pits, and to have a homogeneous paste with the residues from the pulp. This paste at the second pressing will give a common oil of edible quality, which would find a market at a lower price.

I would not now advise making a third quality of oil from the oil cake, because, considering the high price of labor in California, and the fact that the uses to which the product could be put are well supplied by other oils (especially cotton-seed oil), the practice would not be profitable. The extraction of this inferior grade of oil may become practicable when the production of olives becomes large enough to furnish large quantities of oil cake at a low figure, in which case factories for the special purpose of extracting this inferior quality might be profitably established.

In considering the results of our experiments, the conclusion is that so far, among the varieties mentioned, the Manzanillo seems to be the best pickling and the Nevadillo the best for oil. The latter variety, which, compared with the others, has been recognized as a very good bearer, and able to flourish in climate not very favorable to it, ought to be propagated more than has been done so far.

Tests of Purity—Iodine Absorption.

The last column in the table shows some determinations on the "iodine absorption" by the oils obtained by pressing or by chemical extraction, in order to know if this method could be properly applied to discover adulterations in California olive oil.

According to different authors, the ratio of iodine absorption by olive oil may vary from 79.7 to 88, while most chemists do not admit more than 84.5 as a standard, and consider as adulterated every oil which passes that limit.

The maximum of iodine absorption by our pressed oils was 86.5, and in those obtained by extraction with carbon bisulphide 86.6. All the other oils obtained by chemical extraction showed the iodine absorption lower than that of the same oils when obtained by pressing.

We cannot, therefore, rely implicitly upon this method for discovering slight adulterations in California oils, and must extend the limit usually admitted for this factor (84.5) at least up to 86.6 for pure oils.

Taking 88 as the extreme upper limit, it should be mentioned that among a number of samples of oil sent us by producers and others, the extreme minimum of iodine absorption was found to be 81.1, while among the highest figures were 89.2 and 92.9. Accordingly, these two samples might be considered as adulterated, but as yet we reserve our judgment in the premises.

In view of this uncertainty it will be well to mention here a simple and sure method by which adulteration with cotton-seed oil (most used for adulteration) can quickly be discovered. It was devised by Prof. E. Bechi, Director of the Agricultural Station at Florence, Italy. It has been officially adopted in the chemical laboratories of the Italian Custom Houses. This method serves to reveal the presence of cotton-seed oil in all seed oils, and even in cod liver oil. It may be thus briefly described:

An alcoholic solution of nitrate of silver is made in the following way:

Nitrate of silver	1 gram.
Alcohol at 98 per cent	200 cubic centimeters.
Ethylic ("sulphuric") ether	40 cubic centimeters.
Nitric acid	1 decigram.

Another solution is also made of:

Amylic alcohol (fusel oil)	100 cubic centimeters.
Pure colza (rape-seed) oil	15 cubic centimeters.

The reaction is made in the following way: To ten cubic centimeters of the oil to be tested add one cubic centimeter of the silver reagent and ten cubic centimeters of the solution of colza oil in amylic alcohol; stir briskly and divide the mixture so obtained into two equal parts; warm one half for a quarter of an hour at the boiling point of water, and compare with the other half to see if there has been any change of color. In case of any addition of cotton-seed oil, a dark brownish-red coloration will be obtained.

According to the author the same result may be obtained without using colza oil, but he employs it in order to obtain always a uniform coloration. As can be seen, this method is very simple and within reach of any intelligent operator.

IMPORTATION OF OLIVE VARIETIES.

The following varieties of olives were imported from the highly reputed nursery of R. Pecori, of Florence, under the auspices of Prof. E. Bechi, the Director of the Agricultural Station at Florence, Italy; they were received February, 1891:

1. *Bella de Spagna.*—Its oil is very fine, but it is generally used for pickling.

2. *Leccino.*—On account of its hardiness, ought to be propagated in those regions frequently subject to damage by frost. The fruit is pretty large and fleshy, but not rich in oil: it is, however, a heavy bearer.

3. *Olivo piangente* (weeping olive).—This beautiful variety is somewhat delicate, therefore it requires mild regions, where it will be a good bearer. Its fruit yields a very agreeable and sweet oil, but it is also good for pickling purposes.

4. *Santa Caterina.*—Bearing large fruit: very fine for pickling.

5. *Infrantoio.*—One of the best olive oil varieties from Tuscany; large bearer.

6. *Correggiolo.*—According to Professor Caruso, is the same as the Infrantoio.

7. *Morinello.*—This is widely cultivated in Tuscany, because in stands cold weather and the action of the winds very well. The fruit contains more flesh than the Infrantoio, but the oil is not so fine.

8. *Ascoli.*—Bearing large fruit; very fine for pickling purposes; of high value, both for Italian and foreign markets.

These trees are now growing finely on the grounds of the station at Berkeley, and will be propagated as rapidly as possible for distribution to the sub-stations, and thereafter to olive culturists at various points within the State.

OLIVE-OIL ADULTERATION.*

By L. Paparelli.

In the trade we find many kinds of olive oil, the tastes and the qualities of which depend, within certain limits, upon many circumstances, such as the variety from which the oil was obtained, the manner and the time at which the fruit was picked, the methods in use in the oil factory, etc., all of which are natural differences.

Oils are mixtures of several substances furnished by nature, and the process of elaboration of which is in large part unknown. So we must not be surprised if, in the analytical test, the reactions are not always distinct for the same oil, although given as characteristic and sure.

Olive oil consists of a mixture of "glycerids:" palmitin, stearin, olein; and we may consider that the first two are in the average proportion of 28 per cent, and the third 72 per cent.

The oils that frequently are added to olive oil are the oils of cotton seed, sesame, poppy, rape seed, and peanut. Other oils also are used for adulteration of olive oil.

Therefore, when we receive an olive oil claimed to be pure, we will have to solve the following questions:

Is it a pure olive oil? Is it adulterated with cotton-seed oil? Or is it adulterated with oils from other seeds?

* Part of a paper read before the meeting of the Olive Growers Association, San Francisco, July 8, 1891.

To answer such questions the examination of both the physical properties and the chemical reactions of the suspected oil is necessary; and while in some cases one or two tests may be sufficient to enable us to pronounce an opinion, in most cases we must submit the oil to *all* the tests recognized at present as characteristic, and only from the whole of the results obtained can we decide with certainty on the purity of the oil.

Tests of Adulteration.

The physical characters of each sample must be first examined, viz.: color, odor, and taste. The latter two always give useful indications regarding the purity of an olive oil, but they can be appreciated only by an expert. The specific gravity should also be determined, although that of most seed oils does not differ much from that of olive oil. Those oils of which the specific gravity is materially different are generally not used for adulteration.

The point of fusion and of solidification of the free fatty acids, the specific heat, the electric conductivity, the capillarity coefficients, etc., of the oil may be taken into account in the examination; but all these physical properties differ so little in the different oils, that although valuable in distinguishing each from the other, they are useless when the oils are mixed.

We will give special attention to the chemical reactions now known as characteristic and quite decisive for most cases.

Iodine Absorption.—The iodine number is the percentage of iodine absorbed, while cold, by a hundred parts of oil. About .03 grams of oil are dissolved in 10 cc.* of pure chloroform and mixed with 20 cc. of an alcoholic solution of iodine and chloride of mercury: the liquid is kept in bottles well closed for about two hours in a cool and dark place. In the same conditions are kept another 20 cc. of the same iodine solution with 10 cc. of chloroform, and its strength is determined by a decinormal solution of hyposulphite of soda. The differences between the quantity of the hyposulphite employed to destroy the color of the iodine solution which has been in contact with the oil and that needed to destroy the color of an equal quantity of iodine solution unmixed with oil, represents the iodine absorption of the oil itself.

As has been stated already in Experiment Station Bulletin No. 92, according to different authors the ratio of iodine absorption by olive oil may vary from 79.7 to 88, while most chemists do not admit more than 84.5 as a standard, and consider as adulterated every oil which passes this limit.

But this test cannot be altogether relied upon, because iodine absorption has been found higher for pure olive oils, as may be seen in the above mentioned bulletin. In Italy, also, Professors De Negri and Fabris have found for pure olive oil higher iodine absorption (87.9).

The causes which produce this variability, so far as studied, are the following:

1. The riper the olives from which the oil has been made the higher is the iodine absorption.
2. Old and rancid oil has generally a slightly lower number.
3. The method of oil-making has also its influence; that is, oil made from the pulp only, shows a slightly lower iodine absorption than that

* Cubic centimeters.

obtained by grinding pulp and pits together; oils extracted by chemical solvents have a lower iodine absorption than the same obtained by pressing; oil obtained from the pits always shows a higher iodine absorption than that extracted from the flesh.

4. It seems the largest influence is due to the olive variety from which the oil is made; in fact, some varieties always show a very high figure.

On the whole, then, the conclusion is that high iodine absorption, even up to 88, is not always indicative of adulteration with seed oils, but may be on account of the quality of the oil itself. Therefore, in order to determine with certainty whether an olive oil is or is not mixed with seed oils, we must take into consideration the other chemical tests which give more definite results.

Bechi's Reaction.—(For this test, see the description given in Experiment Station Bulletin No. 92, above.)

Hauchecorne's Reaction.—Stir six grams of oil briskly with two grams of pure nitric acid, and warm the mixture for about twenty minutes in a bath of boiling water. Olive oil treated in this manner becomes pale colored, or acquires the yellow color—proper to fine olive oil in case it was dark colored before being tested. On the contrary, it becomes yellowish-orange or reddish-brown when mixed with seed oils.

Brulle's Reaction.—To 10 cc. of oil add one decigram of dry albumen in fine powder, and 2 cc. of pure nitric acid. Warm carefully this mixture until the acid begins to boil, and then stir well, continuing to warm till the albumen is completely dissolved, which occurs in a few seconds. Genuine olive oil at this point becomes almost colorless, and after cooling it becomes more or less turbid, but of a fine yellowish straw color, which it retains for a long time; after twenty-four hours it becomes completely solid and remains of the same color. On the contrary, when seed oils are present the coloration is from yellowish-orange to reddish-brown at the time of the dissolution of the albumen by heating, and generally they do not solidify.

Heidenreich's Reaction.—Into a porcelain capsule with flat bottom put enough pure concentrated sulphuric acid to make a surface as large as a silver dollar, and on it let fall five or six drops of the oil to be tested. Observe carefully the coloration produced during three minutes at the points of contact of the oil with the acid; this coloration in pure olive oil should be yellowish or greenish-yellow; and in seed oils from yellowish-orange to reddish-brown. This reaction in many cases might produce an error; it is therefore necessary not to rely on that test alone.

Baudouin's Reaction.—A very characteristic reaction of sesame oil is the property it has of turning crimson-colored a solution of sugar in concentrated hydrochloric acid. The reagent is prepared by dissolving one gram of sugar in 100 cc. of hydrochloric acid. To one volume of this solution add two volumes of the oil to be tested, and stir briskly for some time. After some minutes of settling, the aqueous liquid which separates is uncolored if no sesame oil is present, but in the contrary case is colored crimson, more or less intensely.

Schneider's Reaction.—Colza, or rape-seed oil, like other oils of the crucifers, contains sulphur; therefore, when carefully treated with silver nitrate it produces a black coloration, due to the formation of sulphide of silver. For this test dissolve the oil to be tested in twice its volume of ether, and stir the liquid with about 5 cc. of a saturated alcoholic

solution of nitrate of silver. After twelve hours allowed for settling in a dark place, a black coloration or precipitate is obtained in case of the presence of oil from crucifers, especially after the evaporation of the ether.

The above represent the best tests known for ascertaining the purity of olive oil; but the greatest care in the preparation of the reagents and in the operations are required, otherwise the most skillful chemist may err in the determination. The correct appreciation of colors also requires considerable experience.

FIBER PLANTS FOR CALIFORNIA.

The Production of Ramie.

By E. W. Hilgard.

(*University Experiment Station Bulletin No. 90.*)

The revival of interest in the culture of ramie that has followed the announcement of the apparently successful tests made of a new decorticating machine at the late Mechanics' Fair, renders it desirable to review some of the main points of this industry as bearing upon its adaptation to California. The great beauty of the fiber and the almost unlimited commercial demand for it when brought into the market in available form; its adaptation to a great variety of soils and climates; the high production; the perennial nature of the plant that renders its culture very inexpensive; last, but not least, the possibility of easily maintaining the productiveness of the soil by a return of the "trash," placing ramie near to cotton (when the seed is returned) as bearing very lightly on the soil's native fertility; and, finally, the relatively high value and light weight of the merchantable product when shipped—all these advantages concur in rendering the culture of this fiber plant specially desirable wherever it is feasible. That it has not become more widely spread, and has not largely superseded the much more costly and exhaustive culture of flax, is mainly due to the difficulty of accomplishing the separation and cleaning of the fiber by a machine sufficiently effective to compete with the scraping by cheap hand labor, which, in the Orient, is the habitual and the only mode of supplying to commerce the "China grass"* fiber.

This difficulty arises from the presence in the bark of a gummy substance that encases the fiber, and from which it must be thoroughly freed by either mechanical or chemical processes, or by both combined, before it can be worked.

Two essentially different plans have been pursued in the effort to accomplish this. One is the "wet" process, in which (as in the Orient) the green stalk is operated upon, requiring appliances somewhat distinct from those used in the preparation of hemp or flax fiber; while in the "dry" process the mechanical operations are substantially the same kind as in the case of our familiar fiber plants, but modified to suit a

*The gross inappropriateness of the latter name may render it desirable to repeat here, for the benefit of those to whom the subject is new, that the ramie plant is a large, stingless, broad-leaved nettle, and therefore belongs to a family of plants of which many other members supply valuable fibers.

specially difficult case. In either mode the mechanical treatment has to be followed by a more or less intense chemical one, for the removal of the last remaining greenish gum from the silky fiber before the latter is ready for the spinning machine. The latter, in view of the great length of the ramie fiber, should be of the kind adapted for "line" spinning; but of course it is quite feasible to convert the fiber into tow or short length material, resembling long-staple cotton. Some of the older machines have done this; and if, as is now stated, such material can find purchasers among the workers in wool and cotton at remunerative prices, there is little difficulty about its production in large quantities. But one of the merits of the ramie fiber—its resemblance to silk—is thus grievously impaired, and it may be fairly said that no machine or process that does not produce the fiber in a condition for line spinning can claim to have achieved the problem of making ramie as profitable a crop as it can be.

The "wet" process seems to have had the best success in the countries whose climatic conditions involve a perennially moist atmosphere, and where a thorough drying of the stems is therefore difficult. The principles upon which the work is done are, in general, the breaking of the more or less brittle and "brash" stems, fresh from the field and stripped of their leaves, by means of a suitable modification of the ordinary breaking process as applied to dry stems of hemp, etc. The stemless but undecorticated fiber, usually rolled into bands for the better preservation of its parallelism, is then dried, partially or wholly by artificial heat, so as to render the gum and bark brittle enough to be removed by subsequent beating and combing.

Sometimes this mechanical after-treatment has been omitted and the stemless crude fiber passed directly into the alkaline bath (mostly of common or caustic soda), which is always required to remove the last of the gummy matter, but a too prolonged action of which will impair the strength of the fiber. The latter is then ready for a final combing, and for spinning with or without preliminary bleaching.

The "dry" process differs from the "wet," in that the stalks—cut at the time when their oldest portion is just turning color from green to a brownish tint—are first allowed to dry in the field, if this can be done, and when fully dry are at once subjected to the action of breaking, and of beating, or combing machines, that remove stalk and bark, with gum, in proportion to their perfection, leaving again the crude fiber more or less ready for the alkaline bath, as in the wet process.

It will readily be understood that the *dry* mode of working is best adapted to a dry climate, in which the stalks and gummy bark become so brittle that the breaking and beating is effective to a degree which it would be impossible to attain in moist climates, like those of Louisiana or Guatemala, except by artificial heat, which, as stated, is therefore generally used in connection with the *wet* process. Hence, the dry mode of working promises exceptional advantages where—as in the interior of this State—the dryness of the summer air is proverbial. The dry process also possesses the advantage that each machine can be kept running continuously on practically uniform material; while in the wet mode of treatment the plants must, in a large field, either be worked at very different degrees of maturity, or else the crop must be attacked with a large number of machines, in order to secure uniformity of the product; after which the machines will lie idle. It would therefore seem, on

the most general principles, that where the dry process is climatically feasible it offers advantages over the other method, provided an equally good merchantable product can be turned out.

Without discussing the merits of the different machines now offered to producers as a guarantee that their crop, when grown, will be convertible into a merchantable article, and of which I, personally, am not at present fully informed, it should be said as regards the *culture* of ramie that by actual trial it has been found to be readily feasible in all the larger valley regions of the State, so far as the successful growth of the plant is concerned; but that it will, doubtless, prove most profitable where a long growing season, combined with irrigation, permits of making three or four cuts annually. In the Kern Valley there is little difficulty in getting *four* cuts, of good size and quality, and the same is probably true on the stronger soils as far north as Fresno, and southward in the valley of South California. In the Sacramento Valley *three* cuts can, doubtless, be obtained, at least when irrigation is employed, or in naturally moist land. At Berkeley, and elsewhere on the immediate coast, *two* cuts (the second usually a small one) are all that can be counted on; but in warm valleys of the Coast Range, doubtless from two to three full crops, according to the supply of moisture and the strength of the soil, may be looked for.

The following table shows the record of crops of the white-leaved ramie (*Urtica nivea*) harvested during four years on the Berkeley experimental grounds, the last of seven. No manure was used on the plot, but it was reset in 1888 in order to equalize the stand which had been impaired by the distribution of roots; hence, doubtless the low product in that year and a later cut. The size of the plots, of which the record is here given, is eighteen by thirty-four feet, or about one seventy-first of an acre. The green plants were weighed with the leaves, which are estimated at about one half of the "live weight." The dry stalks were weighed practically leafless:

Results of Experimental Culture of Ramie on the University Grounds, Berkeley.

Date of Cutting.	Plot.	Yield—Pounds.	Yield Per Acre.	Percentage, Dry to Green.
FIRST CROP.				
1887—June 24	1	576½ green	40,932	
1888—July 16	1	491 green 135½ dry	34,861 9,621	27.6
1889	1	624 green 133 dry	44,304 9,443	21.3
1890—July 9	1	763 green 122 dry	54,173 8,662	16.0
1890—July 9	2	623½ green 117 dry	44,269 8,307	18.8
SECOND CROP.				
1887—October 31	1	174 green	12,354	
1890—November 21	1	210 green 74 dry	14,910 5,254	35.2
1890—November 21	2	102 green 38 dry	7,241 2,698	37.2

Assuming for the years during which the observations of the product were (on account of frequent calls for samples) not as full as during the last, the same average ratio as to the weight of the two crops and

the percentage of dry stalks yielded, we find that the product has been at an average rate of about nine thousand pounds of dry stalks per acre for the first cut, and about five thousand two hundred and ten pounds for the second. This gross weight of course would be somewhat less in the dry air of the interior of the State; but the figures show that on strong soils the expectation of eighteen to twenty thousand pounds per acre, where four cuts can be made, is not extravagant. The minimum product from dry stalks is estimated to be 15 per cent of raw merchantable fiber. Upon these data an approximate estimate of the crop, and of its financial outcome in the several climatic regions of the State, may be based.*

It is hardly necessary to remind any intelligent farmer that only *strong* soils can be expected to produce, in one season, a crop of ten tons of dry stalks of *any* kind, and that few can continue to produce such crops for many years without substantial returns to the land, no matter how fertile originally; but there is no reason why the offal of the ramie crop—the leaves and the stalk trash—should not be regularly returned to the soil. The leaves can be, and are usually dealt with by stripping the stalk on the ground, leaving them where they grew. As to the stalks, it is true that with three or four cuts per season it will be difficult to deal with the large mass of refuse by spreading it on the stubble, although in the more northerly portions of the area of cultivation it may be desirable to use this material for protection against frost. But, as the return must either be made, or fertilizers furnished, the proper mode of procedure will be to make compost heaps of the trash and thus render it less bulky, and convenient for spreading on the stubble after the last cut. This, in the case of strong soils, is all that will be required to keep up production for a long time, although the raw fiber sold represents a larger proportion of the soil's plant-food than in the case of cotton, in which the return of seed and stalk will maintain production indefinitely on any soil capable of yielding a profitable crop. When *no* returns are made, ramie will prove even a more exhaustive crop than is cotton when the seed is not returned; and those engaging in its culture had better understand from the outset that they can "rob the soil" with ramie even more effectually than with wheat.

On the strong, black, adobe soil of the Berkeley experimental plot, where purposely no return or fertilization of any kind has taken place,

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* Mr. Goncet de Mas, who grows the ramie at Padua, Italy, planted it twenty by twenty inches, or sixteen thousand plants per acre, and gives the following as his results:

First Year.—Cut 39,700 pounds, of which 19,800 pounds were leaves. On drying, the stalks weighed 3,970 pounds, which, by decortication, yielded 883 pounds of fiber.

Second Year.—First cutting	75,386 pounds.
Second cutting	69,757 pounds.
Total stems and leaves	145,143 pounds.
Green stems	72,571 pounds.
Dried stems	14,514 pounds.
Fiber	2,604 pounds.
Third Year—The plants thinned out to forty by forty inches.	
First cutting	90,640 pounds.
Second cutting	87,640 pounds.
Total green stems and leaves	178,280 pounds.
Green stems	88,990 pounds.
Dried stems	17,600 pounds.
Fiber	8,520 pounds.

the crop of 1890 was fully as large as any previous one within the four years in which weighings had been made. Owing to the constant call for plants, the ground has never been solidly occupied by the crop; but even in the year in which the plot was reset in spring, with half the stocks, the product was nearly up to the average, so rapidly do the plants tiller and spread.

Among the strongest soils in the State are those containing more or less of "alkali," and as these are mostly valley lands, the question of their adaptation to ramie culture is important. Experiments have shown that while ramie is a little more sensitive to alkali than alfalfa, it will stand all but the strongest spots, *provided the alkali is not of the "black" kind*, viz.: carbonate of soda; and as the conversion of black alkali into "white" is easily effected by the use of proper doses of plaster or gypsum, it may fairly be said that with this proviso, ramie may be grown in alkali lands available for little else, since the growing of alfalfa cannot be carried beyond a limited point with profit to the producer, on account of its relatively low value and heavy weight in transportation. The main reason why ramie will grow in alkali ground is the same as in the case of alfalfa: because it shades the ground, and hence the evaporation, going on through the leaves of the plants instead of at the surface of the soil, will not accumulate the noxious salts around the root crowns so as to corrode them. But it must not be forgotten that until the plants fully shade the ground, the rise of alkali in the *middles* must be prevented by thorough tillage, otherwise damage may result, in that the outermost roots suffer and the spread of the plants is retarded.

As against alfalfa, ramie also possesses the advantage that, as it is not propagated from seed (in the field at least), but by the division and the setting-out of plants or their roots, the difficulty of obtaining a stand on account of the rotting of the seed by the alkali, does not exist.

So far, then, as the successful and profitable growth of the plant is concerned, there need be little doubt in the valleys of the central and southern parts of the State, so soon as the processes for marketing the fiber shall be an assured success.

Composition of the Ramie Plant.

By M. E. Jaffa.

(*Experiment Station Bulletin No. 94.*)

In Bulletin No. 90 ("Fiber Plants for California," June 23, 1891) special mention is made of the exhaustion of the soil by the production of ramie. The object of the present investigation is to show the actual amounts of soil ingredients withdrawn by the different parts of the plant, and to point out the great necessity of returning to the soil the leaves and stalks after decortication.

Experiments on a small plot upon the University grounds, and on a much larger scale by M. Goncet de Mas, at Padua, Italy, have proved that on good soils, where from three to four cuts can be made annually, the yield will be about ten tons of dried stalks per acre. M. Goncet de Mas, in the third year after planting, obtained from two cuts nearly nine tons of dried stalks. We are told by Mr. McAfee, of Bakersfield, that the best fiber is produced when three, instead of four cuts, are made

annually. The total yield of the three will not differ materially from that of the four cuts, the weight of each cut in the former case being proportionately heavier. The tables given below, showing the total amounts withdrawn from the soil, are based upon these maximum figures.

Separate analyses were made of the ashes of the leaves, stalks without bark, and bark, *i. e.*, cuticle and fiber, including gum. The cuticle and fiber were analyzed together, because, while the leaves and stalks can be readily returned to the soil, it will hardly be feasible to do so with the cuticle and gum; and, as stated above, our present object is to ascertain what can and what cannot be given back to the soil.

Chemical Composition of the Plant and its Ash.

It is found that five tons of wet or fresh stalks are equivalent to one of dry.

We find that the leaves constitute about 30 per cent of the dried plant, the decorticated stalk 51 per cent, and the bark 19 per cent. Of the latter, nearly 15 per cent is raw fiber, containing 30 per cent of gum, thus making the percentage of pure fiber in the plant as grown here about 11.

Referred to stalk, *without leaves*, as 100, the results are as follows: Decorticated stalk 73 per cent, whole bark 27, of which 6 is cuticle and 21 decorticated fiber with gum. Thus the proportion of pure fiber referred to stalk alone is about 15 per cent.

Table No. 1 shows the proximate composition of the different parts of the plant, and also the results of the analyses of the ash of the several parts:

TABLE NO. 1.

Proximate Analysis of the Ramie Plant.

	Whole Plant.	Stalk.*	Bark.†	Leaves.
Water	81.36	81.75	80.91	80.65
Organic matter	17.25	17.68	18.78	15.54
Ash	1.49	.57	.31	3.81
Totals	100.00	100.00	100.00	100.00
Ash in dry substance	7.950	3.120	1.620	19.690
Nitrogen in fresh plant	.258	.146	.210	.481
Albuminoids in fresh plant	1.612	.912	1.312	3.016

*Stalk without bark.
†Including fiber and gum.

Analysis of the Ash.

	Whole Plant.	Stalk.	Bark.	Leaves.
Potash (K_2O)	11.82	37.79	32.58	4.18
Soda (Na_2O)	2.35	8.15	8.77	.54
Lime	30.87	17.32	22.28	34.74
Magnesia	7.89	10.58	11.64	7.02
Ferric oxide and alumina	2.41	2.96	.84	2.35
Br. oxide of manganese	.17	.35	.18	.12
Phosphoric acid (P_2O_5)	7.29	16.38	12.64	4.72
Sulphuric acid (SO_3)	2.26	3.46	3.68	1.88
Silica	33.01	1.56	5.24	42.42
Chlorine	2.43	1.87	2.75	2.55
	100.50	100.41	100.60	100.52
Less excess of oxygen due to chlorine	.50	.41	.60	.60
Totals	100.00	100.00	100.00	99.92

An inspection of the figures representing the percentage in the ash of the whole plant shows that *lime* is the most abundant ingredient, being 30.87 per cent; next comes *potash* with 11.82 per cent, while that of *phosphoric acid* is only about one fourth that of lime, viz., 7.3 per cent.

In the ash of *leaves*, also, by far the most prominent ingredient of plant-food is lime, forming a little more than one third of the whole ash; potash and phosphoric acid amounting to less than 5 per cent each. The predominating element in the ashes of the *stalk* and *bark*, on the contrary, is *potash*, being in the former case more than 37 per cent, and in the latter almost one third of the weight of the ash, thus indicating the heavy draught made on the soil in this respect. The percentages of phosphoric acid in the stalk and bark are nearly three and one half and two and one half times, respectively, that contained in the leaves. Lime, while not present in such large quantities as in the leaves, still occupies a very prominent place among the ash ingredients of all parts, the stalk containing 17.32 per cent, and the bark 22.38 per cent.

In considering the relative values of the different ashes, it must not be forgotten that, although the figures given represent pounds per hundred of the *ash*, it will require a very much smaller quantity of the *leaves* to make one hundred pounds of ash than is the case with either stalk or bark. Thus, about five hundred pounds of dried leaves will yield one hundred pounds of ash; but three thousand two hundred pounds of dried stalks and six thousand two hundred pounds of bark will be necessary to produce the same amount of ash.

Fertilizing Value of the Ash.

In Table No. 2 are shown more clearly the fertilizing values of the ashes of the different parts of the plant; it presents the amounts of mineral ingredients actually withdrawn from the soil per acre. It is calculated for a crop of ten tons of dried stalks per acre, and, of course, where the yield is not so large, the draught upon the soil is proportionately less.

TABLE No. 2.

Amount, in Pounds, of Soil Ingredients Withdrawn from One Acre Annually, by Four Cuts of Ramie Yielding a Total of Ten Tons of Dried Stalks and Four and One Quarter Tons of Leaves.

	Whole Plant—14¼ Tons per Acre.	Stalk—7¼ Tons per Acre.	Bark—2¾ Tons per Acre.	Leaves—4¼ Tons per Acre.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Potash (K_2O)	251.98	155.99	27.86	68.13
Soda (Na_2O)	50.14	33.63	7.52	8.99
Lime	657.82	71.77	19.14	566.91
Magnesia	168.27	43.68	10.01	114.58
Ferric oxide and alumina	51.43	12.16	.71	38.56
Manganese oxide	3.57	1.45	.20	1.92
Phosphoric acid (P_2O_5)	155.70	67.71	10.86	77.13
Sulphuric acid (SO_3)	48.56	14.53	3.17	30.86
Silica	704.25	7.06	4.48	692.71
Chlorine	51.85	2.50	7.79	41.56
Nitrogen	369.70	105.85	57.75	206.10

A consideration of the data given in the table proves to what an alarming extent the soil would be depleted by a continuous culture of ramie when nothing is returned; as no soil, no matter how rich originally, could long withstand such a great strain upon its resources.

The total amount of mineral ingredients withdrawn by a single crop (four cuts) is two thousand one hundred and forty-three pounds, which must be considered as permanently removed when neither the leaves nor the stalks are used as fertilizing materials. The draught made on lime is about six hundred and fifty-eight pounds, on potash two hundred and fifty-two pounds, phosphoric acid one hundred and fifty-six pounds, and on nitrogen to the extent of three hundred and seventy pounds, per acre. Of the potash about three fifths, or one hundred and fifty-six pounds, is contained in the stalks, more than one quarter, or sixty-eight pounds, in the leaves, while the bark and fiber, the only production aimed at, contains a little above one tenth, or twenty-eight pounds, of the total amount.

The leaves contain nearly 87 per cent of the total lime taken from the soil, that found in the stalk being about 10 per cent, and that in the bark 3 per cent.

Of the total phosphoric acid withdrawn, the leaves absorb almost 50 per cent, or seventy-seven pounds, the stalk 43 per cent, or about sixty-eight pounds, while only 7 per cent, or ten and eighty-six hundredths pounds, is found in the bark.

The depletion of the soil in nitrogen is greatest through the leaves, which have more than 55 per cent of the total, or two hundred and six pounds; about 29 per cent, or one hundred and six pounds, is found in the stalks, while in the bark there is only 15 per cent, or about fifty-eight pounds.

It will thus be seen how very small is the proportion of plant-food withdrawn by the bark and fiber, as compared with that by the leaves and stalks; and since the fiber is beyond comparison the most valuable product sought, it is obvious that its continuous production should, above all, be assured.

The ingredients first to be exhausted by such a continuous culture would in all probability be phosphoric acid and nitrogen, owing to the

fact that so many of the soils of this State, notably those of the valleys, while rich in potash and lime, are very poor in phosphoric acid, and sometimes in nitrogen. In sections where irrigation can be practiced, potash and lime will frequently be supplied to the soil in considerable quantities by the irrigation waters, for analyses of the latter show them to contain appreciable amounts of these elements. Lime occurs in them in the form of gypsum (thus also replacing to some extent the sulphuric acid needed by the plant) and carbonate of lime; the potash is generally found as sulphate. Notwithstanding this, the soil's supply would soon be diminished, and the replenishment would have to be made by fertilizers containing high percentages of *all* the ingredients which go to make up plant-food. No "special" fertilizer would answer the purpose.

If, on the other hand, the *leaves* and *stalks* are returned to the soil, the amount of mineral matter withdrawn is, comparatively speaking, very small, being only about twenty-eight pounds of potash, nineteen of lime, eleven of phosphoric acid, and fifty-eight of nitrogen per acre. A strong soil could withstand such a small demand for a considerable length of time without showing an appreciable diminution of crops; and whenever fertilizers become necessary, it will probably be found that in California, phosphoric acid and nitrogen are the substances to be supplied. When the decorticated stalks *only* are returned to the soil, as might be the case if the *leaves* were sold to paper mills, as has been suggested, then about sixty-eight pounds more of potash, five hundred and sixty-seven of lime, seventy-seven of phosphoric acid, and two hundred and six of nitrogen per acre are taken away from the soil than would be the case were they, with the stalks, given back to the land.

Whether or not it would pay to sell the leaves is a financial question depending on the prices obtained for them, and upon that which would have to be paid, sooner or later, for fertilizers used instead.

Should the *stalk* not be used as a fertilizer, then the amount of potash permanently removed from the soil would be increased by one hundred and fifty-six pounds, that of lime by seventy-two, phosphoric acid by sixty-eight, and that of nitrogen by one hundred and six pounds, quantities forming, with the exception of lime, a large percentage of the total mineral matter withdrawn.

As regards the *manner* of returning the "offal" of the ramie plant to the soil, the following paragraph from Bulletin No. 90 will be of interest:

"It is hardly necessary to remind any intelligent farmer that only *strong* soils can be expected to produce, in one season, a crop of ten tons of dry stalks of *any* kind, and that few can continue to produce such crops for many years without substantial returns to the land, no matter how fertile originally; but there is no reason why the offal of the ramie crop—the leaves and stalk trash—should not be regularly returned to the soil. The leaves can be, and are usually dealt with by stripping the stalk on the ground, leaving them where they grew. As to the stalks, it is true that with three or four cuts per season it will be difficult to deal with the large mass of refuse by spreading it on the stubble, although in the more northerly portions of the area of cultivation it may be desirable to use this material for protection against frost. But as the return must either be made, or fertilizers purchased, the proper mode of procedure will be to make compost heaps of the trash, and thus render it less bulky, and convenient for spreading on the stubble after

the last cut. This, in the case of strong soils, is all that will be required to keep up production for a long time, although the raw fiber sold represents a larger proportion of the soil's plant-food than in the case of cotton, in which the return of seed and stalk will maintain production indefinitely on any soil capable of yielding a profitable crop. When *no* returns are made, ramie will prove even a more exhaustive crop than is cotton when the seed is not returned, and those engaging in its culture had better understand from the outset that they can 'rob the soil' with ramie even more effectually than with wheat."

COMPARISON WITH OTHER CROPS.

A comparison of the amounts of mineral ingredients withdrawn by the ramie with those removed by other crops, will more forcibly show how a soil can be robbed by its continuous culture without returns being made. This is shown in Table No. 3.

Fiber Plants Compared with Ramie.

Of all the fiber plants ramie stands first as regards depletion of the soil of plant-food, a result which was to be expected from the greater mass of the plant harvested, since from three to four cuts can be made of the ramie, while only one each of hemp and flax is made. Taking average crops, hemp is second in total amount of ingredients removed, cotton third, and flax fourth. Thus the total quantity of potash that is withdrawn by ramie is about two hundred and fifty-two pounds, that by hemp one hundred and one pounds, by flax forty-four pounds, and thirty-five pounds by cotton. The corresponding figures for lime are: ramie six hundred and fifty-eight pounds, hemp one hundred and thirty-one pounds, flax twenty-three pounds, and cotton forty-four pounds.

As regards the total amount of phosphoric acid withdrawn, the ratio is somewhat altered, in that flax *with seed* causes a severer drain in this respect than hemp, the figures being: ramie one hundred and fifty-six pounds, flax forty-one pounds, hemp thirty-three pounds, and cotton twenty-three pounds. It will be seen from a comparison of the above figures that when nothing is returned to the soil the depletion is less with cotton, so far as phosphoric acid and potash are concerned, than with either of the other fiber plants, and that the total amount removed by a good crop of ramie is more than the combined weight withdrawn by flax, hemp, and cotton, illustrating again the impoverishing effect of this plant on the soil.

The total amount of nitrogen withdrawn by ramie is three hundred and seventy pounds, which is about six times that removed by hemp and five times that by flax. The data at hand for cotton are insufficient for comparison of the *total* quantity carried off, but the seed takes away from the soil by far the greater part of the whole amount of nitrogen required by the cotton plant; hence it will be readily seen that ramie has a much more exhaustive effect on the soil than has cotton, with reference to this costly ingredient.

When the refuse materials for the different plants are returned to the soil, even then the ramie still stands first in depleting the soil of nitrogen; in fact, it removes fifty-eight pounds against an insignificant amount by the fibers of the other plants.

TABLE No. 3.

Amount, in Pounds, of Soil Ingredients Withdrawn from One Acre by Various Crops.

	Potash	Soda	Lime	Magnesia	Br. Oxide of Manganese	Iron and Alumina	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine	Total	Nitrogen
RAMIE—												
Leaves, 4.25 tons	68.13	8.99	566.91	114.58	1.92	38.56	77.13	30.86	692.71	41.56	1,641.35	206.10
Stalk (without bark), 7.25 tons	155.99	33.63	71.77	43.68	1.45	12.16	67.71	14.53	7.06	2.50	410.48	105.85
Bark (cuticle and fiber), 2.75 tons	27.86	7.52	19.14	10.01	.20	.71	10.86	3.17	4.48	7.79	91.74	57.75
Whole plant, 14.25 tons	251.98	50.14	657.82	168.27	3.57	51.43	155.70	48.56	704.25	51.85	2,143.57	369.70
HEMP—												
Leaves, 1,975 pounds	56.46	.47	98.62	11.55			18.70	4.46	11.36	.34		
Stems, 3,000 pounds	44.44	1.40	24.86	5.51			12.91	1.63	.75	.51		
Clean fiber, 1,000 pounds	.40	.08	7.22	.65			1.61	.05	.49	.01		
Whole plant, 5,975 pounds	101.30	1.95	130.70	17.71			33.22	6.14	12.60	.86		62.74
FLAX—												
Straw, 1,800 pounds	23.04	2.43	13.63	3.60	.18	.76	7.87	4.02	1.60	2.26	59.39	18.00
Seed, 1,724 pounds	20.60	1.19	5.80	9.75	.35	1.45	32.00	.07	.29	.04	71.54	56.54
Fiber, 600 pounds	.13	.30	3.27	.30		.24	.72	.18	.34	.05	5.53	
Whole plant, 4,124 pounds	43.77	3.92	22.70	13.65	.53	2.45	40.59	4.27	2.23	2.35	136.46	
COTTON—												
Leaves, 400 pounds	7.99	4.40	15.03	2.50		2.38	4.22	5.84	3.58	2.75	48.49	
Stems, 1,200 pounds	9.17	3.65	10.58	3.56		.75	4.49	1.99	1.71	2.54	38.44	
Seed, 800 pounds	8.99	1.15	3.07	4.00		.52	9.74	1.11	.51	.48	29.37	29.20
Burs, 400 pounds	7.42	4.59	14.16	3.19		2.66	3.57	6.88	7.40	2.14	52.01	
Lint, 400 pounds	1.69	.42	1.20	.46		.12	.52	.24	.08	.36	5.09	
Whole plant, 3,200 pounds	35.26	14.21	44.04	13.71		6.43	22.54	16.06	13.08	8.27	173.40	
WHEAT—												
Grain, 20 bushels	7.85	.14	.72	2.57		.22	11.90	.34	.24	.02	24.00	24.00
Straw, 3,000 pounds	36.07	1.54	10.32	3.95		1.54	7.90	6.59	146.26	7.87	222.04	18.00
Whole plant, 4,800 pounds	43.92	1.68	11.04	6.52		1.76	19.80	6.93	146.50	7.89	246.04	42.00
SUGAR-BEETS (Fresh)—												
Roots, 40,000 pounds	152.00	24.00	16.00	24.00		3.00	36.00	12.00	8.00	12.00	287.00	60.40
Tops, 32,000 pounds	235.44	198.48	208.08	171.60		13.68	80.16	68.64	36.96	49.68	1,062.72	113.00
Whole plant, 72,000 pounds	387.44	222.48	224.08	195.60		16.68	116.16	80.64	44.96	61.68	1,349.72	173.40

NOTE.—The data for the above table have, with the exception of that for ramie, been taken from the various station reports and bulletins.

If the seed, in the cases of cotton and flax, is sold in place of returning it to the soil, then the flax and ramie bark carry away about the same amount of nitrogen, while cotton takes only one half that quantity.

If the soil is replenished by the "offal" or refuse products of the several plants, viz., returning all but the fibers, then, as regards *potash*, the quantity removed by ramie is 28 pounds, by cotton less than 2 pounds, .42 of a pound by hemp, and .13 of a pound by flax. Were the seed in the case of cotton used otherwise than as as fertilizer, even then the amount would be only about eleven pounds, which is considerably less than one half of the figures for ramie. In other words, for the withdrawal of the same number of pounds of potash carried off by a single crop of ramie yielding ten tons of dried stalks per acre, there would be required sixteen crops of cotton, sixty-six of hemp, and two hundred and fourteen of flax. The number of pounds of *lime* necessary for the ramie is 19, for hemp a little more than 7, for flax about 3.25, and 1.2 for cotton; or, making as before a comparison by crops, we have the result that one crop of ramie is equal in exhaustive power to 16 of cotton, about 2.5 of hemp, or to 6 of flax.

The *phosphoric acid* of the soil is drawn upon to the extent of 11 pounds for ramie, 1.6 for hemp, .72 for flax, and .52 for cotton, showing, in regard to this as other ingredients, that ramie causes the greatest strain on the soil.

When flax is grown for fiber *and* seed, then the relation between it and ramie, so far as soil exhaustion is concerned, is materially changed, inasmuch as that when the seed is sold, the potash permanently removed is twenty-one pounds (in place of .13 of a pound when the seed is used in fertilization), or more than two thirds of the quantity required by the ramie. The phosphoric acid is also very much increased, and, instead of being less than one tenth, is then *three times* the amount withdrawn by ramie. In this case flax has a much more exhaustive effect on the soil than has ramie, because, although it uses up less lime and potash and about the same quantity of nitrogen, it draws much more heavily on phosphoric acid, which, as has been previously stated, is found in the soil of this State only in small proportions, there being on the contrary very generally an abundance of lime and potash.

Wheat vs. Ramie.

Comparing ramie to wheat, we find from the table that when the leaves and stalks of the former are returned to the soil, the potash withdrawn by the bark is not nearly so much in amount as in the case of wheat, being about 28 pounds for ramie as against 44 for wheat. The phosphoric acid is not much more than one half that of wheat crop, the figures being 11 against 20. Hence, as regards these two elements of plant-food, wheat impoverishes the soil to a greater extent than does ramie, when stalks and leaves are returned.

Just the opposite conclusion is to be drawn when we compare the lime and nitrogen contents, particularly so in reference to the latter, which is taken from the soil to the extent of 106 pounds in the case of ramie, as against 42 for wheat; the proportion for lime is as 19 is to 11 pounds.

If nothing of the ramie "offal" is used as fertilizing material, then

the soil is robbed much more effectually than is done by wheat, and in the ratios indicated by the following figures: Potash, 252 to 44; phosphoric acid, 156 to 20; lime, 658 to 11; nitrogen, 370 to 42.

Sugar-Beet vs. Ramie.

The data given in the table for the sugar-beet will be of special interest to the farmers who are now raising them, or who contemplate so doing.

The amount of potash removed by a twenty-ton crop of roots is 152 pounds, and by the tops 235. Of phosphoric acid, 36 by the roots and 80 pounds by the tops. A still greater difference is shown in the case of lime, the roots drawing on the soil to the extent of 24 pounds as against 195 for the tops, or more than eight times as much. The nitrogen in the tops is nearly double that found in the roots, as indicated by the figures 113 and 60.

A careful consideration of the above will at once show the great benefit to be derived from, and the absolute necessity of, returning to the soil the sugar-beet tops; which, fortunately, is almost always done in practice.

It is readily seen from the table that the cultivation of the sugar-beet, when the tops are *not* returned to the land, will impoverish the soil in potash in a much shorter time than is the case with ramie, even when the entire plant is removed.

As regards the other costly ingredients, phosphoric acid and nitrogen, it will be seen that the ramie plant as a whole draws much more heavily on both than does the beet, and in the case of lime the difference reaches the proportion of nearly three to one. When, however, all but the bark is returned in the case of ramie, and in that of the beets all but the root, the amount of potash taken away from the soil by beets is 152 pounds, or equal to about five times that by the ramie. The difference is not very marked in the case of lime, ramie requiring 19 pounds and the beets 16. The same can be said concerning the nitrogen, for which ingredient the figures are 106 and 113; whereas, the phosphoric acid in the beets, 36 pounds, is nearly three and one half times that of the ramie. It thus appears, that when in beet culture the tops are returned, the draught upon the soil is on the whole much heavier than in the case of ramie, as it requires so much more potash and phosphoric acid, while the amount of nitrogen is about the same in each.

Fruits vs. Ramie.

Owing to the insufficiency of the data at hand a comparison of ramie with the fruits, as regards the total amount of mineral matter withdrawn by the different crops of the latter, cannot be made; but those quantities can be compared which are permanently removed in each case, as shown in Table No. 4:

TABLE No. 4.

Quantities of Soil Ingredients Withdrawn by Various Fruit Crops Compared with Ramie Bast and Fiber.

FRESH FRUIT.	Total Ash. Pounds.	Potash. Pounds.	Phosphoric Acid. Pounds.	Nitrogen. Pounds.
Grapes—Crop of 10,000 lbs. per acre	89.00	50.00	15.20	17.00
Oranges (California)—Crop of 20,000 lbs. per acre.	86.40	40.14	10.60	36.00
Pears—Crop of 20,000 lbs. per acre	93.00	36.00	10.00	12.00
Plums—Crop of 30,000 lbs. per acre	87.00	51.00	13.20	167.70
Apples—Crop of 20,000 lbs. per acre	44.00	16.00	6.00	12.00
Ramie bark (dry)—Crop of 5,500 lbs. per acre	91.74	27.86	10.86	57.75

It will be seen, as regards total mineral matter, that while that of the ramie does not differ materially from that of grapes, oranges, or plums, it has a trifle more than double that of apples and about one and four tenths times that of pears. Its content in potash is not much more than one half that found in grapes and plums, considerably less than in the case of oranges and pears, but is one and three fourths times that of apples. The phosphoric acid percentages are almost identical in the ramie bark, orange, and pear; grapes and plums containing, respectively, 50 and 30 per cent more than does the ramie; while apples have only about 60 per cent of that amount.

In nitrogen-contents ramie stands second to plums. Grapes carry off a little less than one third, oranges about three fifths, and pears and apples somewhat more than one fifth of that removed by the ramie.

On the whole, then, ramie culture, when all "offal" is returned, is fairly comparable to the less exhaustive fruit crops; but without such return it must be classed among the most exhaustive cultures known.

FLAX FOR SEED AND FIBER.

By E. J. WICKSON.

(University Experiment Station Bulletin No. 90.)

Occasional efforts have been made during the last fifteen years to establish the manufacture of linen fabrics in California by those claiming to be practically acquainted with the industry elsewhere, but the proprietors of such enterprises have abandoned the undertakings because of the alleged lack of interest among local capitalists. Whether this is the true reason for the failure to establish flax spinning in this State or not, we do not pretend to state.

It has been frequently stated that the production of flax for both seed and fiber is not feasible, and our farmers who have grown flax for seed have therefore abandoned the thought which has frequently arisen in their minds, of gaining something for their flax straw as well as for their seed crop. It seems likely that an erroneous impression has thus been engendered, for there are recent authoritative statements to the effect that not only is the production of both seed and fiber from the same plant not impracticable, but that "by far the larger part of the flax grown the world over, is for the double crop and double profit of both the seed and fiber."* We are also assured that "it is possible to

* New York "Dry Goods Economist," October 18, 1890.

grow for both seed and fiber, though the fiber will be coarse, naturally, and only fit for the lower classes of manufacture."†

It is possible, then, that even in growing flax for seed, as now practiced in this country, the fiber could be made a source of income, provided the straw was not disintegrated, as in the prevailing mode of thrashing. It is also possible that by selecting a better variety of flax than commonly grown for seed, and by sowing more thickly, so that the growth of the lateral branches on the main stem is measurably repressed, there might be secured a fiber product vastly better than is now obtained, and therefore fitted for a higher class of manufactures. This procedure might result in a lessened production of seed by the individual plant, and perhaps a reduction in the aggregate yield per acre; in fact, in our experiments with flax varieties, we find that the best European fiber varieties yield much less seed than the variety commonly grown for seed in this State.

It may be concluded, then, that though to grow flax both for seed and fiber requires closer thought and greater effort than are usually given to the flax crop, and that to make the straw available to manufacturers requires some investigation and investment on the part of the flax grower, the current claim that one cannot grow flax for both seed and fiber is not necessarily true in the nature of the case, nor in the experience of the greater number of the flax growers of the world.

In order to minister to the oft-recurring demand from inventors for California-grown flax straw for trial in their machines and processes, and to furnish seeds to growers who desired to experiment, we secured from Europe, years ago, four of the best fiber flax varieties, and have grown them from year to year on the experiment grounds of the Berkeley station. They have attracted much attention from visitors for their beautiful, straight, tall growth of stem and bright, clear color. The growth of the four varieties has been quite similar, as shown by the record of 1890:

Variety.	Sown.	Germinated.	Bloomed.	Harvested.
Russian	April 12	April 23	June 5	July 24
Yellow-seeded	April 12	April 23	June 2	July 24
White-flowered	April 12	April 23	June 2	July 24
Royal	April 12	April 23	June 5	July 24
California	April 12	April 23	June 10	August 4

The European fiber varieties are thus shown to require a shorter growing period than the California seed variety. The fiber varieties averaged one third longer in straw than the Californian; they branched less and produced much less seed. Accurate weighings of straw and seed have not been secured hitherto, because the plots were invaded from time to time to furnish specimens for exhibition and for experimental fiber extraction by local inventors. This year careful weighing will be made.

Though these flaxes have aroused considerable interest here in the manner stated, there has been no result in local fiber treatment that is worth mentioning. Seed was sent to Washington Territory, and straw

† Report on flax, hemp, etc., by C. R. Dodge, United States Department of Agriculture, 1890.

grown there was sent to European flax manipulators, who returned a very favorable report. On April 29, 1890, we received a circular request, addressed by Mr. S. S. Boyce, President of the Boyce Fiber Company of New York, to the various experiment stations of the United States, asking for samples of flax straw, which he agreed to work for fiber and report results. Mr. Boyce did not describe his process, but it is stated by Mr. Dodge (in his report to which allusion has already been made) to be "a process for cleaning flax without first submitting the straw to the process of retting, thereby obtaining the fiber at once." Such a process naturally would be more attractive to the flax grower, for the time, labor, and water required in retting are all probably of higher cost and more difficult to command in this State than in other regions where flax is grown.

The New York "Dry Goods Economist" of October 18, 1890, contained a description of the working of the flax straw sent to Mr. Boyce from this station, with engravings of the several bundles as received by him. The following is a condensed tabular statement, which we compile from the data in the article referred to:

Weights of Seed, Straw, and Fine Fiber from California-Grown Flax Varieties.

VARIETY.	Gross Weight.	Seed.	Straw.	Fine Fiber.
Yellow-seeded	19	7	12	2¼
Russian	16	6	10	2¼
Royal	15	6	9	2¼
White-flowered	15	7	8	2
California	14	7	7	1¼

Comments upon the experiments are, that the Russian and Royal seemed to be best, both for seed and fiber. The California gave much the largest yield of seed, and the seed was very large and plump, but the fiber was coarse and weak.

Of the general results of the experiment, the "Economist" says:

"There is no tow by this process of retting. The natural color of the straw was very light; that of the fiber almost perfectly white in each sample. The total yield of the fiber, 23 per cent of the weight of the straw, was rather a light yield of fiber, but very fine. The yield of fiber is greater when the straw is not overripe. The samples treated had been allowed to get riper than required for either seed or fiber.

"The results of this trial are of interest as showing clearly the superiority, from a textile point of view, of the flax varieties which this station has introduced to this coast over the common variety which is grown for seed. Whether it is possible to realize more by the attempt to produce both seed and fiber here, and to substitute one of these varieties for the one commonly grown, is an industrial question depending upon manufacturers and capitalists for solution. The farmer cannot afford to produce a crop of any kind until a market is assured."

GRAPES AND OTHER CULTURES.

NEW PERSIAN GRAPES.

By L. PAPARELLI.

It has long been known that the valley of Persia produces some of the finest grapes known to the world. None of these grapes have been brought to America until recently, but after some correspondence, Prof. H. E. Van Deman, the well known pomologist of the United States Department of Agriculture, succeeded in procuring stock. He writes as follows, under date of December 2, 1890, to Professor Hilgard:

> I have the pleasure of sending to you at the Central Station, seventy-seven grapevines, which comprise seven varieties, and are sent under numbers instead of names, because there has been some mistake made either by Minister E. Spencer Pratt, or the person who received them at the propagating houses of this department. I, however, feel sure that this matter will be straightened up, and that in due time I will be able to give you the correct names. In the meantime you may propagate them according to your judgment. Some are not in very good condition, but I think all will grow. They are among the choicest kinds of grapes grown in Persia.
>
> I also have just sent to the station at Tulare, eleven varieties of the grapes received from the same source, and for which we have the correct names, as follows: *Askaree, Alhakahee, White Shahanee, Chavooshee, Hutab, Dizmar, Khallilee, Black Shahanee, Rish Baba, Paykanee, Razukee,* and *Shiraz.* I sent them there direct, because I thought you would likely want them there, but if I am mistaken, you can order them just where you think best. The same varieties have been quite generally distributed throughout the State. I trust that they will all grow, and that in the future something may come of them in that delightful home of the grape. A few of the vines are in rather poor condition, because they were propagated quite late in the spring from single eye cuttings. Of No. 20, there are eleven vines; of No. 21, twelve; of No. 22, ten; of No. 23, fourteen; of No. 24, eight; of No. 25, ten; of No. 26, twelve vines.

The rooted grapevines were reshipped from Tulare to the Central Station, where they were potted and placed in the propagating house. They are being pushed as fast as possible, and a fairly large stock will be ready to be sent out next year.

GRAPES FROM ITALY.

By L. PAPARELLI.

(*Experiment Station Bulletin No. 91.*)

Very few of the kinds of European grapes peculiar to Italy have been brought to California. "Crabb's Black Burgundy," identical with the Italian "Refosco," was one of the first of the type. John T. Doyle, Esq., imported the *Nebbiolo*, the *Barbera fina* of Asti, and the *Freisa* of northern Italy. Later came the *Aleatico*, *Provinante*, such white grapes as the *Lignanga* and *Pizzutello*, and perhaps five or six other Italian varieties of reputation.

The University has now obtained cuttings of forty-eight kinds of Italian wine and table grapes. They are from the vineyards of Count Rovasenda, of Turin, a famous authority on grapes and wines. They are being rooted in pots, from single joints, so as to increase them as fast as possible; some have been grafted on older stock. In a year the Station will have complete sets, and a year later a general distribution can be made of the Italian as of the Persian varieties.

If it is asked what is the especial value of this class of grapes (the Italian), the answer is, that good dry wine which keeps well cannot be expected under conditions of greater heat when northern grapes are

cultivated. Both Italy and Spain make dry wines. The warm parts of California must depend more upon the Spanish and Italian varieties. These varieties, and also the Persian, are intended for the dry interior valleys, the warmer foothills, and the southern counties.

The varieties obtained can be briefly described as follows:

Aspiran noir.—A French table grape, making a delicate and bright wine; rather thin for market.

Cipro nero.—Comes from Cyprus; makes one of the best wines known there. Late in ripening; a good table grape.

Cesanese nero.—The variety that is grown extensively on the Roman Campagna; makes a good and strong wine.

Grisa di Piemonte.—A leading late wine and table grape of the Piedmont districts.

Negro amaro.—Another good bearer; a wine grape.

Negro dolce.—Said to be the same as *Dolcetto nero.*

Paga-debito.—A black grape good for wine.

Monica.—One of the best of the Sardinian wine grapes.

Neiretta.—Black; heavy bearer; favorite Piedmont sort.

San Gioveto.—From Tuscany, and blended with such sorts as *Freisa, Barbera,* and *Canajolo.* Used in many of the best Tuscan wines.

Tadone.—From Piedmont; wine strong and dark.

Bolgnino.—A wine grape from Saluzzo.

Neretto grosso canavese.—A very acid and dark wine grape.

Croattina.—A large, round black grape of Piedmont; best in deep soils.

Danugue.—The same as the Nice variety, *Gros Guillaume;* large, late.

Antibo.—A Saluzzo variety.

Quagliano.—A very fine table grape for light soils. Might prove an excellent shipping grape.

Ocru di bove.—Sardinian variety, late, black, large berry.

Bermestia violacea.—Another large-berried Piedmontese kind.

Pelaverga.—A reddish-black Saluzzo kind, used for table and for a special sweet wine.

Croetto, Erbalus di Caluso, and *Bellino* are all Piedmontese varieties of reputation.

Corbeau is already known in California.

Chenin noir is a good French variety.

Two Tuscan varieties of promise are *Mammolo toscano,* which has a violet bouquet, and *Malvasia di Brolio.*

Barbarossa di Finalborgo is an excellent keeper, and used for table and wine.

Favorita, said to be the *Vermentino di Liguria,* is a good white wine and table variety.

Vernaccia sarda, from Sardinia, is one of the heaviest bearers known.

Olivette de Cadenet, from France, seems the same as *Crujidero.*

Catarattu a la Porta.—This is an exceedingly promising variety, one of those used in the wines of Marsala. It comes from Sicily; large yellow grape, late in ripening, and heavy bearer.

Picpoule is another French grape, much planted in Italy.

Pis de chêvre, another French kind, went to Italy by way of Hungary.

Torok goher is a Hungarian variety; also at home in Italy.

Malvasia de Rovasenda is a Sicilian seedling, named for Count Rovasenda; a red-black grape, of good character.

Malvasia de la Cartuja is a Spanish grape, of the same type as preceding, white in color.

Negrara di Gattinara is peculiarly liable to *oidium*; otherwise a fine grape.

Passaretta is a raisin grape of the Piedmont; used also for wines.

Crujidero is a very late white grape for table; Spanish origin.

There are several other grapes, of which little or nothing is yet known.

CULTURE OF THE BLACK WATTLE.

From notes by the late W. G. KLEE.

An important source of tannin is found in several Australian acacias, of the group termed Wattles, viz.: *A. decurrens*, the Black Wattle, and *A. pycnantha*, or Golden Wattle. The products of these, under the name of Mimosa bark, find their way to the London market, where the price is about £8 a ton. The facility with which acacias are grown here along the coast is well known, and naturally recommends them as shelter trees around orchards, if it were not that they are said to be breeders of scale insects. This, however, would not be an objection to raising them for the sake of the bark, as the scale hardly affects the tree seriously until it is large enough for use. The cottony cushion scale, now conquered by the Vedalia, was the chief source of trouble. The danger has been exaggerated; the acacias should be more generally planted. In any case a planter can depend on home-grown trees, and such difficulties can thus be entirely obviated. Baron Ferd. von Müller, the distinguished botanist, has urged the planting of wattles in their native home, ever since he caused the bark to be analyzed, nearly a score of years ago. Nor is this the first time the planting of the wattle has been publicly recommended in California. The reason for doing so again is that we have yet failed to hear of any large enterprise in this direction.

The following estimate of the cost of a plantation of a hundred acres is taken from the report of the Board of Inquiry, appointed to investigate this subject in Australia:

Each acre planted with Black Wattles, ten feet apart, would carry four hundred trees, and at the end of the fifth year would yield fifty-six pounds of matured bark; stripping every third tree, three hundred and thirty-three tons would be obtained from a hundred acres; this, at £4, would give for the first stripping, £1,332.

In the sixth, or following year, a similar number of trees would be stripped; the bark having increased in weight, say fourteen pounds, the increased yield of the second crop would make four hundred tons, at £4 per ton, £1,600.

In the seventh year the remaining trees would be stripped, from which a still greater increase would be obtained, say four hundred and eighty tons, at £4 per ton, £1,920.

The aggregate yield during the first eight years would be one thousand two hundred and fifteen tons, £4,852.

The expenses are calculated as follows:

Rent of a hundred acres, at six shillings per acre per annum	£24
Plowing one hundred acres in drills, ten feet apart	25
Sowing of wattles and actual cultivation, seed included	57
Pruning the trees, taking off useless growth, only necessary for two years, at ten shillings per acre	50
Supervision for eight years, nominal, say £50 per annum	80
Incidental and unforeseen expenses	27
Interest on the whole amount expended during eight years	240
Actual cost of stripping and carting	1,515
Total	£2,637
Profit balance, exclusive of improvements on supplementary savings	2,215

Though this estimate requires considerable modification in its special terms, it does most likely not exceed the probable. No doubt one hundred acres could be bought for the £250, or $1100 an acre; land suitable for this purpose exists in large quantity in different counties, such as Santa Cruz and Monterey, and others, in regions partly covered with pines, where the soil is too poor for any kind of fruit or grain.

In the Australian estimate the expectation is to raise new trees from seed to replace those cut down. This, perhaps, would not be needed, as the wattle here almost invariably sends up sprouts from the roots, which grow with greater rapidity than the seedlings; such, at least, is the case in good soils. It will also be seen that in this estimate no allowance is made for the value of wood, which, from trees eight years old, would be considerable.

Acacia decurrens is comparatively seldom seen in California, the *A. dealbata*, or Silver Wattle, generally known by the name of *A. mollisima* in the nurseries, being the one most commonly planted.

The two are easily distinguished by the time of bloom; *dealbata* blossoms in January, *decurrens* in June. They can also be distinguished when in fruit, the Black Wattle being characterized by having the pods contracted between the seeds, making it next to impossible to get the latter out without breaking the pod altogether. *Dealbata*, on the contrary, which is also known by the bluish-white hue of the foliage, has the seed lying rather loosely in the pod. This latter species, so often planted around San Francisco Bay, and confounded with the other, is, according to Baron Von Müller, very valuable for fuel, but not rich enough in tannin for tanning purposes. As regards the *A. pycnantha*, it is known that it will grow particularly well in poor soil, but it is of rather small size for profitable tanbark production.

DISTRIBUTION OF SEEDS AND PLANTS, AND DONATIONS RECEIVED.

By E. J. Wickson.

The distribution of seeds, plants, scions, etc., has been regularly carried out since the inception of this branch of work early in the history of the Berkeley station. In the report of 1885–6, summaries were given of earlier distributions, and in subsequent reports general allusions were made to the work. It is intended to give, herewith, a tabular showing of the extent and cost of distribution and an outline of the materials transmitted. By including the years which have elapsed since the

last full report, data are secured for an interesting comparative showing.

The seeds and plants distributed are chiefly grown at the Berkeley station. Occasionally, when wide trial is desired of some lauded novelty, home-grown material is supplemented by purchase. The plan is to issue, annually, announcements (*vide* University Bulletins, Nos. 61, 76, 81, 84 and 89) of the material which it is desired to place in the hands of local experimenters, inviting each to choose for himself that in which he is most interested, and to require applicants to remit money enough to meet the cost of packing and postage, as nearly as it can be estimated. This rule is enforced, because it prevents application from those who would thoughtlessly apply for whatever costs nothing, and it bespeaks interest enough on the part of the applicant to prompt a faithful trial of the material sent him. This plan of distribution has worked very well, as is shown by the hundreds of reports, from which data have been compiled for the different parts of this report; and to these specific discussions, elsewhere, the reader is referred for fuller information concerning the plants included in the summaries below:

Number of Plants and Cuttings Distributed.

NAME.	1886-87.	1887-88.	1888-89.	1889-90.	1890-91.	Total.
Trees—Black wattle	185					185
Guava	201	102				303
Kikar	205					205
Olive	224		804			1,028
Camphor		985				985
Cork oak		268	535			803
Date palm		188			56	244
Melon		92				92
Strawberry		212				212
Sumac		46				46
Tea		108				108
English oak				210	260	470
Kai apple				280	128	408
Carob					136	136
Fiber plants—Esparto grass	70	20	60	50	10	210
New Zealand flax	50	130	125	75	90	470
Ramie	270	160	130		90	650
Forage plants—Australian salt bush		10	480			490
Texas blue-grass roots			1,320		7,050	8,370
Plants—Bamboo	49	374	146	48	49	666
Caper				306	195	501
Licorice roots					285	285
Cuttings—Grape	3,156	3,120	3,420	460	330	10,486
Mulberry	965		4,120	1,190	1,140	7,415
Willow				1,340	810	2,150
Olive						560
Totals	5,375	5,815	11,140	3,959	11,189	37,478
Scions—Fruit (number of orders)	133	28	24	19	28	232

Weight, in Ounces, of Seeds Distributed.

NAME.	1886–87.	1887–88.	1888–89.	1889–90.	1890–91.	Total.
Cereals—Wheats	1,008	1,300	.....	1,584	960	4,912
Barleys	.....	992	.....	736	1,856	3,584
Oats	.....	704	.....	.....	832	1,536
Ryes	.....	.....	.....	.....	768	768
Buckwheat	.....	56	.....	.....	.....	56
Fiber—Flax	924	352	.....	172	104	1,552
Cotton	.....	.....	.....	392	328	720
Jute	.....	.....	.....	68	20	88
Forage—Grasses—Millet (*Milium multiflorum*)	126	59	.....	86	36	307
Schrader's brome	568	99	404	408	176	1,655
Hungarian brome	.....	168	608	160	88	1,024
Japanese wheat	.....	.....	156	382	96	634
Tall oat	.....	.....	159	.....	72	231
Japan clover	86	.....	.....	.....	.....	86
Snail clover	.....	294	160	148	76	678
Kaffir corn	122	.....	440	400	.....	962
Yellow millo maize	.....	140	.....	.....	.....	140
Black medic	.....	82	128	.....	.....	210
Esparcette, or sainfoin	.....	.....	1,524	384	192	2,080
Tagasaste	.....	55	272	.....	.....	327
Hairy-flowered paspalum	.....	.....	134	54	22	210
Jersey kale	.....	.....	178	86	82	346
Garden—Corn	.....	1,028	1,724	.....	.....	2,747
Peas	.....	38	338	196	.....	572
Pumpkins and squashes	.....	221	200	.....	.....	421
Beans	.....	.....	590	.....	224	814
New Zealand spinach	.....	.....	41	.....	40	81
Beets	.....	.....	.....	202	202	404
Trees—Black wattle	84	210	202	.....	59	555
Sumac	.....	22	.....	.....	.....	22
English oak acorns	.....	.....	624	.....	.....	624
Sundry—Pyrethrums	114	272	230	118	80	809
Quinoa	80	37	.....	.....	.....	117
Chuna	.....	39	.....	.....	.....	39
Tobacco	.....	250	.....	.....	221	471
Dyer's madder	.....	.....	13	6	.....	19
Chapman's honey plant	.....	.....	.....	112	80	192
Totals	3,112	6,473	8,125	5,669	6,614	29,998

Extent of Distribution.

	1886–87.	1887–88.	1888–89.	1889–90.	1890–91.
Number of applicants supplied	631	589	818	471	514
Orders filled by mail	428	427	704	377	426
Orders filled by express	197	324	290	184	148
Post Offices reached	252	247	356	230	277
Express offices reached	111	175	171	121	110
Counties reached	48	45	50	50	*51

*The number of counties in 1890 was 53.

Financial Statement.

	1886-87.	1887-88.	1888-89.	1889-90.	1890-91.
Receipts.					
Coin, stamps, orders, etc., from applicants	$291 70	$475 64	$336 95	$201 30	$244 55
Assistance from Agric. Dept. of University	?*	86 00	73 00	58 00	54 00
Total receipts	$291 70*	$561 64	$409 95	$259 30	$298 55
Expenditures.					
Packing material for seeds	$23 40	$23 95	$33 59	$27 25	$26 89
Packing material for plants	27 03	51 17	46 50	42 20	35 95
Postage, cartage, etc.	85 33	95 51	65 94	41 55	49 54
Stationery	3 70	5 60	7 10	6 85	6 24
Wages	90 25*	228 00	194 75	116 40	150 10
Total expense	$229 71*	$404 23	$347 88	$234 25	$268 72
Am'ts of unfilled orders returned to applicants	61 99	157 41	62 07	25 05	29 83
	$291 70*	$561 64	$409 95	$259 30	$298 55

DONATIONS OF SEEDS, PLANTS, ETC., DURING THE YEARS 1888 TO 1891, INCLUSIVE.

1888.

From F. Von Müller, Melbourne, Victoria, Australia: Seeds of *Acacia longifolia, A. Sophoræ, Alyxia buxifolia, Billardiera longiflora, Clianthus puniceus, Cordyline Australis, Eucalyptus Gunnii* var., *Notoæa robusta, Pisonia grandis, Pittosporum undulatum, P. tenuifolium, P. Ralphii, P. eugenioides, Tecoma Latrobei, Vitex littoralis.*

From United States Department of Agriculture, Washington, D. C.: Seeds: Tobacco, 7 varieties; turnip, 4 varieties; watermelon, 2 varieties; muskmelon, 3 varieties; cucumber, 3 varieties; squash, 2 varieties; radish, 3 varieties; parsnip, 2 varieties; beet, 6 varieties; onion, 2 varieties; celery, 2 varieties; kale, 1 variety; lettuce, 2 varieties; tomatoes, 1 variety; peas, 5 varieties; corn, 7 varieties; sugar corn, 6 varieties; beans, 4 varieties; eggplant, 1 variety; cauliflower, 1 variety; carrot, 1 variety; cabbage, 2 varieties; asparagus, 1 variety; Chinese sugar-cane (*Sorghum vulgare*, var. *saccharatum*); winter wheats, 5 varieties; oats, 1 variety; buckwheat, 1 variety; rye, 1 variety; cotton, 4 varieties; blue lupine, *Vicia velosa, Stipa tenacissima* (Esparto grass), *Spergula maxima, Seradella;* Teosinte (*Reana luxurians*); *Melilotus alba, Abies Nordmanniana; Pinus Laricio* (Corsican pine), *P. resinosa* (red, or Norway, pine), *P. ponderosa* (yellow, or bull, pine), *Taxodium distichum* (bald cypress), *Librocedrus decurrens* (California white cedar), *Juniperus Virginiana* (red cedar). Cuttings: *Salix amygdalina Caucasica, S. amygdalina vitellina, S. amygdalina latifolia, S. purpurea* X *viminalis, S. rubra, S. viminalis* (Belgian, Rough red, Smooth golden, Rough green, and mixed high-growing varieties), *S. purpurea, S. purpurea* (wild), *S. hippophaëfolia, S. viminalis nobilis.*

From J. Hanna & Co., Sterling, Kansas: Seeds: Sorghum, 9 varieties.

From J. M. Thorburn & Co., 15 John Street, New York: Seeds: Potato seedling, Rural New Yorker No. 2; Thorburn's Everlasting cucumber.

* Plus labor furnished by the Agricultural Department of the University, of which no separate account was kept by distribution assistant.

1889.

From U. S. Department of Agriculture, Washington, D. C.: Seeds: *Lupinus*, winter horse beans and hairy vetch, sulla (*Hedysarum coronarium*), seradella (*Ornithopus sativus*), small pea (*Lathyrus sativus*), giant spurry (*Spergula maxima*), *Lathyrus hirsutus*, bird's-foot clover (*Lotus corniculatus*); an assortment of tobacco seeds, also of imported onions, beets, carrots, lettuce, turnips, squash, radish, cabbage, parsnips, tomatoes, cucumbers, muskmelons, watermelons, peas, beans, and corn. Texas blue grass (*Poa arachnifera*), red fescue (*Festuca rubra*), *Festuca elatior;* vetch (*Vicia sativa*), champion honey plant (*Echinops sphærocephalus*), improved white Georgia collards, new white velvet okra, new Japanese buckwheat, Red Kaffir corn, six varieties of non-saccharine sorghum, grown by A. A. Denton, Sterling, Kansas, for distribution by the department; also, eight varieties of saccharine sorghum.

From Jeane Sisley, Rue St. Victor Monplaisir, Lyons, France: Seeds: *Gladiolus grandanensis*, Dahlia (*gracilis striata*), *Calycotome spinosa*, *Cannas*, *Styrax, officinalis*, *Hypericum Canariense*, *Melaleuca* sp. *Nicandra physaloides*, *Ligustrum Chinense*, *Raphiolepis ovata*, *Cotoneaster Simoni*, an assortment of *Iris*, *Euonymus fimbriatus*, *Trachycarpus Fortunei* (Chamœrops), *Rhodotypus kerrioides*, *Ferula Australis*, *Acacia brachybotrya*.

From L. C. Kincaid, Encinitas, San Diego County, Cal.: Seeds of millo maize.

From Dippe Bros., Quedlinburg: Seeds of Kleinwanzlebener beet.

From Mrs. M. A. Boyce, Santa Rosa, Cal.: Plants: *Smilax aspera*, *Libonia floribunda*, or *Benshœnsis*, Jasmine (sp. ?) *Carya*, *Dasylirion serratifolium*, *Agave Balmerii*, *Alœ picta*, *A. zebrina*, *Tecoma jasminoides*, *Swansonia alba*, or *Grayana*, *Peonia arborea*, *Chrysanthemum*, *Mesembryanthemum* sp., *Opuntia*, *Eryobothrya* sp. and one unknown plant from the Sandwich Islands. Seeds: Large *Anona*, small *Acacia* sp.

From S. Frogner, Herman, Minnesota: Two varieties of potatoes.

From Deerbrook, Mississippi: Japan clover seed.

From Delano Moore, Presque-Isle, Maine: Seeds of rutabaga.

From Northrup, Braslan & Goodwin Co., Minneapolis, Minnesota: Seeds of two varieties of peas and cucumbers, and one each of lettuce, beans, watermelon, celery, tomatoes, and pansy.

From D. G. King, San Francisco: Bulbs of *Nerine Japonica*.

From the Government Botanic Garden, Saharampur, India: Seeds of mahwa (*Bassia Latifolia*).

1890.

From U. S. Department of Agriculture, Washington, D. C.: Cuttings of *Salix amygdalina canescens*, *S. amygdalina latifolia*, *S. purpurea* X *viminalis*, *S. viminalis* (*Merriniana*, *stricta*, *sedanensis*, red rough of *Gallica*, green rough of *Gallica*, high-growing mixed), *S. purpurea Schultzeana*. Seeds from South America: *Jubæa spectabilis*, *Cocos coronata*, *C. humilis*, *C. campestris*, *Phœnix reclinata*.

From W. A. Lawson, Marysville, California: Seeds of *Leucadendron argenteum* (silver tree), acacia from St. Helena, Thorn acacia from New Zealand.

From Jacob C. Bauer, Judsonia, Arkansas: Van Deman strawberry.

From T. V. Munson, Denison, Texas: Eight varieties of apple trees, two of pecans, and sixteen of grapes.

From John A. Salzer Seed Co., La Crosse, Wisconsin: New Governor Rusk potato.

From Schuster & Barr, Seattle, Washington: A new strawberry.

From Northrup, Braslan & Goodwin Co., Minneapolis, Minnesota: Two varieties of corn and one each of barley, millet, celery, watermelon, and tomato.

From Dr. Thornton, West Ferndale, Washington: Seeds of the wild plum or apple, Christmas bell, yellow-flowered wattle (*Acacia mimosophylla*), an orchid, yellow *Ganoa*, climbing fern, castor-oil plant, Barbadoes Pride, white-flowered lilac, mimosa from the West Indies, shell plant, licorice from the West Indies, brush Læviger or rattan, yellow bean tree, *Zamia*, *Eucalyptus globulus*, *Clematis glycinoides*, *Clianthus* (?), Flamboya tree, and a few others.

From J. J. Rivers, Berkeley, California: Seed of *Pinus Torreyana*, from San Diego County, California.

From P. L. C. Sheppard, Sydney, Australia: Seeds of Australian nut tree, *Humea elegans*, *Lambertia formosa*, *Eriostemon nerifolium*, *Actinotus helianthus*, *Epacris grandiflora*, *Acacia vestita*.

GRASSES AND FORAGE PLANTS.

By Edward J. Wickson.

Introduction and distribution of grasses and forage plants suitable to the peculiar climates and soils of California, have constituted a leading branch of work at this station ever since its establishment. Notes of progress in this effort have appeared in previous annual reports, notably in the report for the years 1885–6, which was published in 1887. The report of 1889 contained a brief generalization, indicating a number of species which have given much satisfaction to those who have tried them. The bulletins announcing seed distributions in 1886 to 1890 (Bulletins 61, 76, 81, 84, and 89) contain notes of those plants which have been especially commended for trial, and tables, given elsewhere in this report, show how great has been the interest in this branch of our work, and how widely we have distributed seeds of those species which seemed most promising. Letters received from those who have participated in this distribution afford comprehensive data for conclusions as to adaptations and practical values of quite a large group of plants; and compilations from the great mass of testimony embodied in these letters will furnish the basis for this report. Brief extracts from individual reports are given in connection with a brief generalization, because the inquirer can often thus obtain direct local information, which will be of most direct value to him.

It is to be regretted that the data is imperfect, because correspondents so often forget to describe the soils, moisture conditions, and methods of cultivation which, in many cases, might govern the results reported; and where diametrically opposite results are reported from the same locality, diversity of local conditions or the personal equation must be charged with the discord. Bearing these things in mind, the reader will be able to draw many important conclusions concerning the various plants from the testimony presented.

We can usually furnish seeds or roots of the plants under consider-

ation during the months of January and February, and a bulletin is issued each December giving lists, terms, etc. Our distribution is for experimental purposes only. We do not furnish material for large sowing.

JAPANESE WHEAT GRASS—AGROPYRUM JAPONICUM, VASEY.

This is a grass new to science and to cultivation on this continent. Hearing that there was being grown and highly esteemed in New Zealand a grass which had been introduced from Japan, we applied to W. Goldie, Domain Curator at Auckland, for seed, which he kindly sent us in 1886. The plant passed in New Zealand under the indefinite name of "Japanese grass." As soon as we secured a growth from the seed sent us by Mr. Goldie, we submitted specimens to Dr. George Vasey, U. S. Botanist, at Washington, who determined it as a new species, which he will describe as *Agropyrum Japonicum.*

Accounts of the grass from New Zealand describe it as a strong and vigorous grower, stooling rapidly and abundantly, but little affected by drought and exceedingly hardy, producing a reasonable growth all the year round in the Auckland district. By its growth in our experimental plots, the grass has sustained its New Zealand reputation as a strong-growing, drought-resisting grass. We distributed the seed for the first time in 1889, the announcement bringing many more applications than we could fill. The grass, however, is a very heavy seeder, and by sowing an additional plot we were able to satisfy demands for the seed the following year. One plot of Japanese wheat grass sown in January, 1889, made a good stand, covered the ground perfectly, and yielded a heavy crop of seed in August without irrigation. After cutting, the plot was given one irrigation and the second growth started at once, and by December first was again in full head. It has been wholly unaffected by frosts which have seared more tender grasses. The growth of the grass is stocky and leafy but not tall.

Although experiments have not yet proceeded far enough to demonstrate its value, the following notes from correspondents clearly portray some of its characteristics:

George Simmons, Yreka, Siskiyou County.—Japanese wheat grass did not do very well.

Charles Foulke, Arcata, Humboldt County.—Japanese wheat grass ripened a good crop of seed the first summer, and started quickly after the first rains. By the following February it was twelve inches high, while orchard grass and mesquite (*Holcus lanatus*) were but four inches, for we had a very cold, dry winter. I have seen no grass to equal the Japanese wheat for this climate.

Frederick Werner, Westport, Mendocino County.—Very few seeds of the Japanese wheat grass germinated. These plants bore seed, but did not start afterwards. I believe the soil was too strong for it. It is one mile from the coast, and this was the first year after clearing.

J. M. Addington, M.D., Bartlett Springs, Lake County.—Japanese wheat grass does not seem to do well on very dry land without irrigation.

Frank Owen, Zem Zem, Napa County.—Japanese wheat grass is of no great value upon dry hill lands, though stock seem very fond of it.

C. F. Shelton, Bangor, Butte County.—Japanese wheat grass does well. The rabbits are very fond of it, though. It should be thoroughly tried on dry land in the lower foothills.

John Isbister, Sweetland, Nevada County.—Japanese wheat grass, sown in January, grew two and one half feet high and bore seed without irrigation.

Robert Hastie, Clayton, Contra Costa County.—Japanese wheat grass made rather a poor growth the second year from the old roots. It was irrigated until the water supply gave out (June 1st).

L. L. Guss, Brentwood, Contra Costa County.—Japanese wheat grass made a good growth.

Howard Overacker, Centerville, Alameda County.—Japanese wheat grass came up well and spread rapidly on hill land. It headed close to the ground, the head being long, coarse, and bearded. I don't like it as well for stock as oat grass, or many other grasses.

S. J. Irwin, Fresno.—Japanese wheat grass, sown under a live oak tree, germinated well,

but was so eaten down by "varmints" that it did not head. I thought during the summer that it was dead, but when the fall rains came it started up from the old stock and grew finely. It seems to have the lives of a cat, and I believe it will make splendid pasture on hill lands.

George Weiss, Creston, San Luis Obispo County.—Japanese wheat grass, sown in March on black sandy loam, received one good rain after sowing. The plants grew about ten inches high, dried up and died in June.

James Nash, Stuart, Santa Barbara County.—Japanese wheat grass did well, growing about three feet high and producing much seed.

Mrs. L. S. Cleland, Mesa Grande, San Diego County.—Japanese wheat grass grew finely on a loamy hillside, until we had an unprecedented hot spell in July, which cooked the cherries on the trees. This heat burned the grass up completely.

P. B. Litton, Elsinore, San Diego County.—On sandy loam upland the Japanese wheat grass came up and promised well, but never attained much height, and finally dried up altogether.

Edwin Haffenden, Lakeside, San Diego County.—I had no water for irrigation, and the Japanese wheat grass dried out, so that it made very little growth.

W. H. Frink, El Casco, San Bernardino County.—Japanese wheat grass sown in March on dry, sandy loam, attained a good growth.

T. V. White, Sumterville, Alabama.—Japanese wheat grass sown in March germinated slowly, but made a good growth; headed out in July at twelve to fifteen inches high. It stands drought better than oat grass, and retained a dark green color during a dry spell in May, when oat grass was nearly burned up. After two years' experience, I am disposed to commend it highly as a winter grass.

M. J. Hannigan, Pasco, Washington.—The Japanese wheat grass beats the world. It starts earlier than our bunch grass, stands drought as well, and remains green longer. If it stands our winter's freezing, which I have not had a chance yet to determine, it will be of immense value.

TEXAS BLUE GRASS—POA ARACHNIFERA.

This grass is a close relative of Kentucky blue grass (*Poa pratensis*), which is not grown in this State except as a lawn grass; and even as a lawn grass it is being largely superseded by other grasses which are less exacting in their demands for water and work on the part of the grower. Texas blue grass, though resembling Kentucky blue grass in color and leaf, is of much more robust and vigorous habit, takes a much deeper rooting, and is in every way a coarser plant. It is specially commended in the Southern States as a good winter grass, starting early, and growing well, making a winter growth as satisfactory as that of Kentucky blue grass in summer, in regions adapted to it.

After several ineffectual attempts to get a stand of the grass from seed brought from Texas, we secured root-sets from that State in 1888, making distribution of them in that year, as well as securing a good plot upon the station grounds at Berkeley. The growth during the summer of 1889 was very satisfactory; the plants spreading well without irrigation. Two plots have been differently treated; one grown without irrigation, and the other watered three times during the summer from the open hose and thumb. The non-irrigated plot made superior growth, the plants reaching greater height, and spreading better. The reason for this is probably not in any dislike of the plant for water, but because of compacting the heavy clay soil by surface watering. The conclusion seems warranted from our own experience, and from the testimony given below, that in fairly loamy soils in regions of moderate rainfall, at least, Texas blue grass may be expected to speedily secure a good hold on the ground, and resist summer drought remarkably well. Experiments now in progress may win for it a wider commendation. The following extracts from correspondence are important:

C. F. Shelton, Bangor, Butte County.—Texas blue grass failed. It seems to be killed out in dry, hard soil.

Dr. O. S. Phelps, Blocksburg, Humboldt County.—The same objection to Texas blue grass for our large stock ranges, arises as with the brome grass; it must be cultivated at first as you would a corn field. It grows well in winter, and when well started is valuable.

C. W. Mallory, Smith's Ranch, Sonoma County.—I have tried Texas blue grass upon land as dry as can be found in this county, and it has made a good growth, nearly two feet this season, where the native grasses have not made twelve inches growth. It keeps green and growing throughout the season.

B. B. Hogaboom, Franklin, Sacramento County.—Texas blue grass is as hardy a plant as I have ever seen. It thrived on the driest land we have, growing slowly, but continuously all summer, and starting strongly during the winter following.

C. W. Hatcher, Yolo, Yolo County.—Texas blue grass grew and spread all summer on my clay loam—about seven or eight feet to water. It resists drought well.

Robert Hastie, Clayton, Contra Costa County.—Texas blue grass sent up seed stems, but died before perfecting seed, owing, apparently, to lack of moisture.

Austin J. Roberts, San Leandro, Alameda County.—I have been testing Texas blue grass for two or three years, and I find it well adapted to the climate of California, standing our warm, dry summers without dying out, and springing up into vigorous growth as soon as the rainy season commences. It has been grown by me successfully, even on gravelly soils, without a drop of water from May until October, yielding a crop of hay the ensuing summer, at the rate of two tons and a half to the acre. Planted on good soil, and occasionally irrigated during the summer, its growth is luxuriant, affording many cuttings and producing an enormous yield of feed. It is highly relished by stock, either in its green state or made into hay. I have chiefly propagated it from roots, as, from the woolly nature of the seed, it is very troublesome and difficult to sow. I obtained several thousand root-sets from Alabama three years ago, and planted them in rows eighteen inches to two feet apart, and twelve inches between the plants. They soon spread and came together, forming a matted turf. I find this grass stands the cold weather of our winters very well, unaffected in its vivid green color by a temperature of even one or two degrees below freezing. For lawns it would require far less water than the Kentucky blue grass, the grass usually cultivated for this purpose. The strong, rapid, vigorous growth of the Texas blue grass under the stimulus of frequent waterings might be an objection.

Henry Murphy, Milo, Tulare County.—The Texas blue grass roots were potted and well cared for, but they failed to grow.

James Nash, Stuart, Santa Barbara County.—Texas blue grass roots died soon after being planted. We had five nights of very cold weather.

Al. Fielding, Santiam, Linn County, Oregon.—Roots of Texas blue grass, planted in February, died out.

SCHRADER'S BROME GRASS—BROMUS UNIOLOIDES.*

A full account of the introduction of this grass to this State, and its general history, were given in our report for 1885–6. It was also there shown to have special adaptations for California conditions. Our later experience with it, and the full reports which we have recently received from correspondents in nearly all parts of the State, entitle it to rank as one of the best grasses ever introduced. It does not, however, possess the ideal qualities for which California stockmen have been long looking, for there are situations too dry for it, and it is to a certain extent dependent upon volunteer seeding for its permanence. Still, it resists drought wonderfully, and, under moderately favorable conditions, the roots live from year to year. This perennial tendency, together with its free-seeding habit, render it permanent and progressive in most places in which it has thus far been tried. Its wide range throughout the State and many of its special characteristics are well brought out in the following extracts from correspondence:

Mrs. Ada Hall, Alturas, Modoc County.—The brome grass deserves special praise as a forage plant. It stands drought and cold weather well.

Howard F. Webster, Crescent City, Del Norte County.—The brome grass was planted in March, and came up in a short time, but made a poor, straggling growth the first season. It lived through the winter, but made a very poor growth this year.

K. S. Williams, Shingletown, Shasta County.—Schrader's brome grass, sown eighteen months ago on irrigated land, made some growth, and some bunches are still growing.

J. H. Janssen, Redding, Shasta County.—Schrader's brome grass grew rather slowly to about seven inches, after which the stock ate it off, along with the stubble.

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*Botanical synonyms are: *Bromus Schraderi, Ceratochloa Australis*, and *C. unioloides*; other common names are: "Rescue Grass," "Iverson's Grass," and "California Prairie Grass"—the latter being its chief title in Australia.

F. M. Rawlee, Cassel, Shasta County.—Schrader's brome grass grew, and a few stalks made heads last year. This spring a few bunches were observed growing, but all seemed to die for want of water, although sown on ground which I had used as a vegetable garden without irrigation. I consider Schrader's brome grass of no value in this locality.

Fred. Scharr, Red Bluff, Tehama County.—Schrader's brome grass does well here without any cultivation. My land is of an adobe nature, but without the large cracks in summer. There is no peat in it.

G. M. L. Snelling, Paskenta, Tehama County.—I sowed the Schrader's brome grass on adobe land on January 17th, and without irrigation it produced an abundant crop of feed and seed, which all kinds of stock were very fond of. It remained green and continued to grow, though eaten off, until October. I saved a portion of the seed raised and sowed it in November and in January, and none of it came up, nor was it reproduced from the roots, so there is none of it left. I do not know the cause.

Wm. H. Mullen, Big Bend, Butte County.—Schrader's brome grass grew well all the first part of the season. Whether the dry weather or my pigs and chickens got away with it, I know not. Perhaps when the rain comes it may start again.

C. F. Shelton, Bangor, Butte County.—Schrader's brome grass grows well, and I think will be of great value in the lower foothill lands.

Henry Montoux, Williams, Colusa County.—Schrader's brome grass grows vigorously early in the spring, the same as wild oats. It grows from four to five feet tall and makes good green feed or hay.

W. A. McKaig, Little Stoney, Colusa County.—Schrader's brome grass does well here, so far as soil and climate are concerned, but I have been unable to obtain a stand on account of poultry and birds.

George Bates, Brownsville, Yuba County.—Schrader's brome grass grows well, in some cases sixteen shoots to one stool, twenty-seven inches high, bearing heavy heads. It falls, and is therefore not good for hay. I consider it a good pasture grass.

Charles Foulke, Maple Creek, Humboldt County.—Schrader's brome grass was a success. I cut it for seed, and cut it three times afterwards before the rainy season set in. The dry weather seemed to have no effect on it.

C. R. Gabeler, Englewood, Humboldt County.—Schrader's brome grass was sown in the first part of April. It came up well and grew fast. I have cut it for seed three times, and think I shall be able to cut it again. It comes along very quickly after cutting, and if it grows fairly well in winter, it will excel every other forage plant that I have ever tried, alfalfa not excepted.

Henry T. Harbert, Ferndale, Humboldt County.—After three years' trial I am pleased with Schrader's brome grass, and consider it quite equal to other good grasses like orchard grass and rye grass. From a patch of eight square rods, I cut a crop which I fed green in May; and in August I cut again, getting sixty pounds of seed. In October following it was from six to twelve inches high, nice and green. The cold spell which we have sometimes during the winter does not hurt it at all, and in the dry season it is green all the time.

Dr. O. S. Phelps, Blocksburg, Humboldt County.—Schrader's brome grass has done well here where sufficient pains are taken in preparing the ground to give it a good start. It will not succeed sown upon the ground without cultivation.

E. L. Reeves, Willits, Mendocino County.—Schrader's brome grass made a fine growth. It ripens about the same time as grain hay. This is a fine grass, and will do well on any land that will produce an ordinary crop of grain hay. In my opinion, it will yield about as much hay per acre, on average land, as grain hay.

Wm. R. Gaine, Point Arena, Mendocino County.—Schrader's brome grass is doing well, and I think will make a good forage grass for this section.

E. H. Cheney, Smith's Ranch, Sonoma County.—Schrader's brome grass grows well the first year, but like the mesquite grass (*Holcus lanatus*) dies out soon; not suited for a permanent pasture.

Wm. P. Edwards, Penn's Grove, Sonoma County.—Schrader's brome grass was doing very well, but in my absence was plowed under by mistake.

A. Van der Naillen, San Francisco.—Schrader's brome grass, planted very late (on hill land in Napa County), had only one good rain, and did remarkably well—better than Bermuda grass. It is green and juicy as late as September.

Frank Owen, Zem Zem, Napa County.—Schrader's brome grass will be a valuable addition to our pastures, though it seems to require moderately rich and moist soil, and is almost a failure on high, gravelly points.

Geo. B. Cosby, Sacramento.—Schrader's brome grass came up and grew nicely, considering the exceptionally dry season and lateness of sowing. Judging by my very limited experience, I think it valuable as a forage plant.

B. B. Hogaboom, Franklin, Sacramento County.—Schrader's brome grass is a very good grower, starting early and producing an abundance of seeds. It is not affected by frost. It does very well on unirrigated ground. I think it will be a good summer feed, as it grows the whole year, and cattle are very fond of it.

E. W. Maslin, Pino, Placer County.—Schrader's brome grass flourished on unirrigated granitic land, and I shall try to extend its culture.

H. W. Turner, Valley Springs, Calaveras County.—With no irrigation Schrader's brome grass grew awhile on red foothill soil, and then gave up to the unusually dry season.

M. F. Gregory, Jenny Lind, Calaveras County.—Schrader's brome grass grew finely and produced a large quantity of seed which, with the parent stocks, covered the ground with

a dense mat of turf after the fall rains. It seems a valuable acquisition. I grew it on bottom land badly covered with sand from mining debris.

Fred. Greve, West Point, Calaveras County.—Schrader's brome grass I do not think much of. We have another species of brome grass growing wild here, which resembles Schrader's. Cattle will eat it when young, but after awhile they will not touch it, and we would rather not have it on our land.

F. Femmons, Gertrude, Fresno County.—Brome grass grew well and seeded heavily, almost like oats. In the fall I noticed that stock ate it in preference to alfalfa, which grew alongside. In the winter the brome grass came out fresh and green, and I find it scattered in many unexpected places. I am hoping to find it a *valuable* addition to our forage grasses.

A. M. Acton, Gertrude, Fresno County.—Schrader's was planted in a gravelly soil, very poor. It grew very well, although probably not so strong as it might have done had it been planted earlier in the season. I secured a limited quantity of seed, sufficient for another trial.

E. R. Pierson, Raymond, Fresno County.—Schrader's brome grass made an excellent growth on dry, sandy loam, and appeared perfectly at home, while Hungarian brome grass dried up. I believe the former will be an excellent grass for this section.

L. A. Winchell, Fresno City.—The brome grass which I received from the University, two years ago, is certainly a remarkable grower, and prolific beyond any expectation. It is a very desirable grass.

Henry Murphy, Cramer, Tulare County.—Schrader's brome grass seed came up well and made a growth of twenty inches. It resisted drought well and was green all summer, but the frost killed it. I divided my seed with a friend, who had like experience. It will not do in our locality.

Mrs. Philena A. Murphy, Cramer, Tulare County.—Schrader's brome grass was sown April 5th. It made a slow growth, and was killed by frost.

E. D. Wheatley, Delano, Kern County.—The brome grass grew quite well, but it was not properly protected from the rabbits, and I think it is all dead. It was on alkali soil.

C. W. Meade, Pescadero, San Mateo County.—Schrader's brome grass, sown on hillside black loam, germinated scantily, but made a fine growth of about four feet. It is rather more leafy than Hungarian brome. It died down somewhat in the fall. The next year it increased, but since then the native grasses seem to be crowding it out.

F. Spangenberg, Cupertino, Santa Clara County.—The brome grass is valuable if stock can be kept off it until well established. It has kept green with me all the year. In this neighborhood I would prefer alfalfa on the hills, as more abundant in amount of foliage, etc., particularly as alfalfa after two years is hard to pull up, while brome grass is just the reverse.

F. U. Eggleston, Watsonville, Santa Cruz County.—Schrader's brome grass came up all right. I think it is of too slow growth for this section.

Isaac Dakin, Soquel, Santa Cruz County.—The brome grasses have been eaten off this fall, but are green, and will probably start with the rains. I think they will prove valuable.

John Wandell, Hollister, San Benito County.—I planted Schrader's brome grass in a row two hundred feet long. After it came up I watered it. It stooled out two feet wide and made a rank growth. When about four feet high I cut it off six inches above the ground and fed it to cows, horses, sheep, and poultry. All liked it. It afterwards grew five feet high and went to seed. I gathered about ten quarts of the seed. I think it a valuable forage plant, especially where it can be irrigated.

Linwood Palmer, Arroyo Grande, San Luis Obispo County.—The brome grass is a good forage plant.

H. M. Maxwell, San Miguel, San Luis Obispo County.—Schrader's brome grass did not mature seed or thrive in any respect under the same conditions with wheat and bunch grass, which yielded well.

James Dearden, Paso Robles, San Luis Obispo County.—Schrader's brome grass does well here, but the gophers seem very fond of it.

H. Brundage, Montecito, Santa Barbara County.—Schrader's brome grass is rather unsatisfactory.

F. S. Gould, Santa Barbara County.—Schrader's brome grass, sown in rather stiff soil in February, bore seed-heads in May. The Hungarian had in the same time grown but few inches and seemed less vigorous.

W. H. Frink, El Casco, San Bernardino County.—Schrader's brome grass, sown in March on dry, sandy loam, grew fifteen inches high, and remained green until the middle of July.

George Wright, Temescal, San Bernardino County.—Last year Schrader's brome grass seemed a failure, but this year it has come up out of the old neglected roots with a thrifty growth, and I think that on our very dry gravelly soil, with our hot and dry climate, will produce as much as timothy does in the East.

H. H. Gird, Fallbrook, San Diego County.—Schrader's brome grass proved excellent as a dry feed, and came on quickly after the first rain, like the California annuals. One year, however, an early fall rain brought it up, and it perished during a long dry spell following. There seemed no seed left in reserve, as is the case with our annual growths.

Mrs. L. S. Cleland, Mesa Grande, San Diego County.—You cannot recommend too highly Schrader's brome grass for southern pastures. I know of no grass for which I would exchange it. It is now green (September), when all the native grasses are dry and brown. After several years' trial it has stood all tests, and I consider it the most valuable grass I know of for this section.

D. B. Hoffman, Helix, San Diego County.—Schrader's brome grass is doing nicely, though it does not spread as rapidly as I expected. I gave it no irrigation, but it has been well cultivated.

M. E. Spafford, Hardin, Crook County, Oregon.—The brome grass did first rate.

Benjamin Dolbear, Wenas, Yakima County, Washington.—Schrader's brome grass was sown in April, upon ground which could not be irrigated. It grew well until the frosts of December, bearing a great quantity of seed. The cold winter entirely destroyed the roots, as it did also the roots of the Johnson grass. For this reason I think it useless to try the cultivation of these grasses here.

W. E. Willey, Oakland, Mason County, Washington.—The brome grass was planted on dry gravelly soil. It made only a small growth, but is still green (September). It is producing some seed, but would do better on better soil.

HUNGARIAN OR AWNLESS BROME GRASS—BROMUS INERMIS.

This grass was introduced by this station from Europe about ten years ago, and was first offered for distribution in this State in University Bulletin No. 22, issued November 15, 1884. This statement is made in view of the fact that it has been reintroduced as a promising novelty by Eastern experimenters during the last two or three years.

The drought-resisting character of the grass was early seen in our experimental plots in Berkeley; and, grown alongside of Schrader's brome grass, has surpassed it in satisfactory growth, being softer and more leafy, and bearing seed which clings more tenaciously to the stems, which are finer than those of Schrader's brome. Under the conditions prevailing in the central coast region of the State, it may be commended as likely to please the grower better than Schrader's. It does not, however, prove so hardy, and cannot be commended so widely, as the following reports clearly show:

J. M. Davidson, Montague, Siskiyou County.—I am well pleased with the growth of brome grass. The unprecedented drought of this spring prevented it from coming up well; but that which did come up grew finely to the height of about two and a half feet, and contained a wonderful amount of forage leaves. Each plant is now (after our first rains) sending out shoots in every direction, and will, by spring, form a complete sod. This I consider a very important item, as it would thus in a very short time form a sod even if a poor set is obtained by sowing. I think it a very valuable grass for this section.

J. H. Holland, Shasta.—Hungarian brome grass, tried by my neighbors and myself, has not done well, although sown on several different soils and situations.

B. Leighton, Leighton, Shasta County.—Hungarian brome grass, sown April 20th, grew two or three inches high and dried up.

H. A. Wiser, Shasta City.—The brome grass is doing well.

Jackson Sawyer, Table Bluff, Humboldt County.—The Hungarian brome grass grew well in upland soil. The blades grew eight inches high and the seed stalks about two feet. It has been green all the season.

C. R. Gabeler, Englewood, Humboldt County.—The Hungarian brome has made a fairly good growth. I have cut it once. It is still green (September 20th).

Thomas Dickinson, Yager, Humboldt County.—Hungarian grass kept green all summer, but did not make much crop. It has been the worst grass season I have seen here in the hills during sixteen years' residence.

W. A. Coalson, Christine, Mendocino County.—The Hungarian brome grass seed came up well, and is doing well, considering that we had no rain in March or April, and a very light shower in May. In June it rained enough to wet the top of the soil. I think that the grass will do well here when it gets set, but that has to be tried yet.

Wm. R. Gaine, Point Arena, Mendocino County.—The Hungarian brome grass is doing well, and I think will make a good forage plant for this section.

Mrs. Stephen Kempster, Cuffey's Cove, Mendocino County.—The Hungarian brome grass came up and grew very slowly, but not to any height. I think it will do better after the first rain. It was planted in loose sandy soil.

J. M. Addington, M.D., Bartlett Springs, Lake County.—Hungarian brome grass is a splendid forage plant; all kinds of stock *love* it.

A. Van der Naillen, San Francisco.—I sowed the Hungarian brome grass very late (in Napa County) on hill land, and the seed had only one good rain. It did remarkably better than Bermuda grass, being to-day (September ?) green and juicy.

W. A. McKaig, Little Stony, Colusa County.—The Hungarian brome does well here, as far as soil and climate are concerned; rather better than Schrader's brome grass.

E. W. Maslin, Pino, Placer County.—Hungarian brome grass flourished on unirrigated granitic land, and I shall try to extend its culture.

H. W. Turner, Valley Springs, Calaveras County.—The Hungarian brome grass was sown in red foothill soil. With no irrigation it came up and grew well, but it did not stand the unusually dry season.

Raymond Plasse, Jackson, Amador County.—The Hungarian brome grass grew, but did not stand the summer drought of our foothills.

M. F. Gregory, Jenny Lind, Calaveras County.—Hungarian brome grass grew well, but did not ripen seed. The growth started well after the fall rains, but the plant does not seem to have the vitality of Schrader's brome.

C. W. Meade, Pescadero, San Mateo County.—Hungarian grass sown on black loam hillside, northern exposure. Grew three feet high and over; remained green all summer and fall, and started into a quick, strong growth after the first rains, seeming to gain ground against other grasses.

F. U. Eggleston, Watsonville, Santa Cruz County.—The Hungarian brome grass came up all right. I think it is of too slow growth for this section.

Isaac Dakin, Laurel Glen Fruit Farm, Santa Cruz County.—The brome grasses have been eaten off this fall, but are green, and will probably start with the rains. I think they will prove valuable.

A. M. Acton, Gertrude, Fresno County.—Sowing of the Hungarian brome grass seed was delayed until March 14th, and no rain fell after that date. The grass grew, but did not bear seed. It was planted in soil composed principally of decomposed oak leaves, and somewhat shaded. I notice since the fall rains that it is showing up nicely from the old root.

E. R. Pierson, Raymond, Fresno County.—Hungarian brome grass started well, but dried up before going to seed.

Wm. Walker, Olancha, Inyo County.—The brome grass has done well. It seems to be peculiarly adapted to this climate and soil. Our soil is sandy and slightly alkali.

Wm. Lockstone, Jamul, San Diego County.—I don't think much of the Hungarian brome grass.

P. B. Litton, Elsinore, San Diego County.—Hungarian brome grass did not live through the summer on sandy loam upland.

TALL OAT GRASS—ARRHENATHERUM AVENACEUM.

This grass did so well in our experimental plots at Berkeley for a number of years, that we have placed the seed in the hands of a number of local experimenters in different parts of the State. The grass starts quickly after the fall rains, and makes an excellent winter growth. In loose soils, to which it is best adapted, it roots deeply and holds its verdure late in the summer, but it is more sensitive to drought than the brome grasses previously considered. It is, however, kept in summer growth with moderate irrigation, and even without water the roots will, in most regions, survive the dry season. It is chiefly, however, as a winter grass that it is likely to prove valuable on this coast as it does in the Southern States. Data now available indicates the fitness of the grass for Northern California and the upper States of the coast. It is desirable that experiments be made with sowing of tall oat grass with alfalfa to improve winter pasturage. It is known to succeed when sown with red and white clovers in regions where those clovers succeed. It is also desirable to try it as a mixture with orchard grass, which is one of the best grasses for the coast region (at least) of California.

The following testimony is furnished by growers of tall oat grass:

George Bates, Brownsville, Yuba County.—Tall oat grass is something wonderful. I counted in September eighty-two shoots from one stool, all from one seed, planted the last of the preceding April. It is a good grass for hay or pasture, and promises to cover the ground very rapidly. If seed were sown eight inches apart it would cover the ground the first year. At the same distance orchard grass would take three years to cover the ground, and timothy would never do it.

E. C. Coburn, Middletown, Lake County.—Tall oat grass, planted on well-manured, loose soil, made a fair growth and withstood drought tolerably. Most of it sent up shoots with the fall rains and made a good growth. The grass sown on dry pasture was destroyed by rabbits.

Robert Hastie, Clayton, Contra Costa County.—Tall oat grass, sown on plowed ground,

made a growth of about thirty inches, with some seed stems over five feet high. It makes good hay. The birds are very fond of the seed, and stripped the stems, but did not take the seed of other grasses I am experimenting with.

Howard Overacker, Centerville, Alameda County.—Tall oat grass came up quickly and grew well until about two feet high. It ripened in August and was cut for seed. Sprouts immediately came from the roots without irrigation, and volunteers appeared after the first rain. It seems a very valuable grass. It was grown on hilly land back of Mission San José.

M. F. Gregory, Jenny Lind, Calaveras County.—Tall oat grass came up well, but succumbed to the heat, except a few plants which were in good growth in December following.

E. R. Pierson, Raymond, Fresno County.—Tall oat grass grew well on dry, sandy loam, but is not as thrifty as Schrader's brome grass.

Al. Fielding, Santiam, Linn County, Oregon.—Tall oat grass was sown on good wheat land in full exposure to the sun. It grew about four feet high, and seeded well during an unusually hot and dry summer, and started immediately after the rains. I think it is the best grass for pasture in this region. It was the favorite of all who examined my experimental plots.

MANY-FLOWERED MILLET GRASS—MILIUM MULTIFLORUM.

A detailed account of the introduction and early success of this grass was given in our report of 1885–6. For the last few years we have made moderate distribution of the seed as there was call for it. Most growers do not succeed in getting a stand of it. The seed is small and difficult of germination, and often does not appear until the second year. By this time, no doubt, many experimenters forget the place of sowing and relax their care, so that the plant does not receive the protection it should, and it is destroyed by stock before it can get a good hold on the soil. Whether the general failure reported by correspondents is attributable to this cause, or whether the plant has, in fact, a very narrow range of adaptation, it is difficult to determine. The growth of the plant from year to year in our experimental plots is very satisfactory. It makes a thick growth of blades and a very showy seed panicle, and retains its verdure continuously. In addition to the data given in our last report, we have the following:

George Heintzen, Brown's Valley, Yuba County.—The many-flowered millet was sown on February 13th on good loamy soil. I think it should have been sown in the fall, to get the full benefit of the rainy season. It sprouted and grew slowly, but died on account of drought.

W. A. McKaig, Little Stoney, Colusa County.—I was never able to get a good stand of *Milium multiflorum*, but the scattered plants grew luxuriantly, surviving the heat of summer and the cold of winter, until last January, when it was all killed, apparently by severe cold.

C. W. Meade, Pescadero, San Mateo County.—The *Milium multiflorum* sown on black loam hillside grew three feet six inches high. 'It keeps green the year round.

Paul Junker, San Diego.—My place is thirty miles northeast of San Diego, at an elevation of two thousand five hundred feet, with decomposed granite soil. The *Milium multiflorum* was sown in March, but did not germinate until after the fall rains, and grew three feet high without irrigation. Horses and cattle eat it greedily, and it seems to me just what we want in this part of the State.

H. H. Gird, Fallbrook, San Diego County.—The *Milium multiflorum* is a good grass. It spreads itself by seed on pasture lands, and shows green throughout the year. It starts with vigor at the first rain, often being a foot high at Christmas, and grows rapidly in cold weather. In the absence of alfilerilla, and other feed of extra good quality, stock eat it well; they pull it up very badly if they are kept off when it is growing and put on after it has attained height. It seems to stick better if stock are put on as soon as it is well up. I have stools of this grass five years old still vigorous, and showing green all through the year, on a high hill of granitic soil.

RYE FOR WINTER FEEDING.

The growth of rye for winter feeding of dairy and other stock is quite prevalent in the foothill regions of the State, and at points along the east

side of the Great Valley. We have introduced and distributed a large collection of European varieties, which have been tried in comparison with the common rye of the country. One of these, the St. John's Day rye, has proved best adapted to local conditions, and was favorably commented upon in our report for 1885–6. It makes a heavy growth in mid-winter, and it has full strength to maintain its heavy head in most winter storms. The following testimony is corroborative of that earlier published:

Mrs. Annie Davis, Susanville, Lassen County.—We have had two years' experience with St. John's Day rye. Sown in the fall, it makes a splendid growth. We raise it on high land without irrigation. It makes fine hay, as it has so much foliage.

J. R. Boggs, Janesville, Lassen County.—This is a good rye country, as there are thousands of acres of good rich sagebrush land without water to irrigate, which will raise fair rye. The mistake usually made, however, is sowing too thinly to make good hay, and as the ground is not protected from the sun's rays and wind, there is commonly obtained only a small yield of either grain or hay.

KAFFIR CORN AND MILLO MAIZE.

The old variety of *Sorghum vulgare*, known as *Dhoura*, and commonly designated in this State as "Egyptian corn," has for many years proved of great value in this State, both when cut green, as summer feed for stock, and when allowed to ripen its seed, which is widely used for poultry, and, to some extent, as a substitute for barley as horse feed. In the upper part of the Sacramento Valley Egyptian corn has been more widely grown than elsewhere, though it is more or less abundantly grown all through the interior valleys. Near the coast, in the upper part of the State, and to some extent along the coast generally, summer heat is too low to fully carry the plant to maturity, and it is usually adversely reported upon.

During recent years new varieties of *Sorghum vulgare* have been brought forward, and the seed has been distributed from this Station. Of these, two, known as "Kaffir corn" and "Millo maize," have proved most valuable, and are by many pronounced superior to the old variety. They are characterized by a more leafy growth than the old "Egyptian corn," and they bear their seed heads erect. They can be freely commended as fodder plants, yielding several heavy cuts of forage each season, if the ground is sufficiently moist, or, when allowed to ripen seed in a region of adequate summer heat, they may be relied upon as the main source of feed-grain in poultry farming. The following reports relate to the two varieties of sorghum already mentioned:

Fred. Scharr, Red Bluff, Tehama County.—Kaffir corn produced twice as much foliage and weight as the Egyptian corn, and it was green all summer; besides, my stock like to eat it much better.

E. A. Brinkerhoff, Forest Ranch, Butte County.—The Kaffir corn sustains its reputation for resisting drought. No rain fell from the middle of May until the last of September, and not a stalk died from drought. With fairly good soil it is a grand crop both for seed and fodder.

J. M. Addington, M.D., Bartlett Springs, Lake County.—Red Kaffir corn has done well, growing seven feet high, with heads one foot. It sprouts readily after cutting. As fodder, however, stock prefer sweet corn.

Charles Lehn, Windsor, Sonoma County.—Kaffir corn, sown on good garden land May 29th, grew splendidly and reached a height of about four feet. It also started well after cutting for seed, but growth was stopped by heavy rains.

H. B. Carpenter, near Glen Ellen, Sonoma County.—Kaffir corn seems to do well here without irrigation.

C. W. Meade, Pescadero, San Mateo County.—Kaffir corn is in good condition to feed when the first rains come, as it is not injured as fodder corn is, and the cattle are glad enough to eat it then.

A. W. Edwards, Los Gatos, Santa Clara County.—I tried Kaffir corn this year and like it.

It makes lots of leaves, and is green and growing now (September), when all other corn has been pulled two weeks past.

E. Janes, Los Gatos, Santa Clara County.—Kaffir corn does not do very well here. It is too delicate toward both frost and drought.

W. D. Thompson, Corralitos, Santa Cruz County.—Kaffir corn has proved well suited for this mountain district. It kept up a good, strong growth during the last very dry season.

A. L. Bowden, Bitterwater, San Benito County.—Kaffir corn, planted April 10th on poor, gravelly soil, was cut for cow feed about August 1st, and again later. The white variety seeds freely; the red does not seed, but makes more feed, growing twenty-five to thirty stalks to the plant without irrigation.

M. Gorman, San Ardo, Monterey County.—Kaffir corn makes good stock forage, but shows no signs of seed.

J. B. Sayler, Bryson, Monterey County.—The white Kaffir corn makes a good growth and resists drought well.

James Nash, Stuart, Santa Barbara County.—Kaffir corn grew well during the summer, and is sending out new shoots as late as November. I am satisfied it will be very valuable for fodder.

H. Brundage, Montecito, Santa Barbara County.—Kaffir corn has done poorly, for which I can assign no reason, except it be lack of hot weather, owing to proximity to the coast.

D. M. Dimmick, Carpenteria, Santa Barbara County.—Kaffir corn (seed from Georgia) has done remarkably well; much better than Egyptian corn.

Fred. Scharr, Red Bluff, Tehama County.—From the little packet of yellow millo maize I got two and one half barley sacks of grain. The chickens like it as well as wheat, and the stock like it as much as sugar cane, which also grows well here.

J. H. Rafferty, Wyandotte, Butte County.—The millo maize did well. It produced more than any other kind of corn that I have seen. I think it could be cut twice if it had plenty of water.

J. W. Mills, Marysville, Yuba County.—The yellow millo maize has made a finer growth than Egyptian corn that was planted beside it. Stock eat it equally as well, but I am not prepared to say whether it is much superior to the Egyptian, taking all things into consideration. Insects feed on it greedily.

R. E. Mason, Bridgeville, Humboldt County.—The yellow millo maize did not do much. I think this was caused by the long dry spell after it was planted. Then it was so wet all summer that it did not ripen. I planted it in an alder glade, and I think it may have been too wet a locality.

Francis G. Smith, Healdsburg, Sonoma County.—The yellow millo maize is very prolific in seed bearing, surpassing the Kaffir and Egyptian corn, but the stalks are too woody and leaves too small to amount to much for fodder if the seed is allowed to ripen.

Geo. H. Suhren, Suisun, Solano County.—The millo corn did not do well. Corn does not do well on my place.

J. G. Bower, Yolo, Yolo County.—I planted the yellow millo maize on the first of April, and, on account of the dryness of the spring, but little germinated, and the growth was small. Cattle eat the green fodder well, but did not care for it when cured.

Geo. B. Cosby, Sacramento.—The millo maize grew well, and matured large, well-filled heads.

Oscar Smith, Brentwood, Contra Costa County.—I planted the yellow millo maize on loose sand. Our heavy winds killed three fourths of it when it was small. The rest of it is still alive and growing. I have gathered one twenty-two by thirty-six-inch wheat bag full of the ripe seed heads, and I think there will be as much more, besides the fodder. I think it will be valuable on my dry sandy lands. This has been an usually dry season here.

Chas. E. Sanders, Gilroy, Santa Clara County.—We planted the yellow millo maize in our garden, but it was late. It looks pretty well. Some of the stalks measure five feet four and one half inches high, and it has not tasseled out yet (September). The soil is adobe and sand.

Mrs. Mabel Luke, Soledad, Monterey County.—The yellow millo maize did well. In yielding it is far ahead of any species of corn that I have planted up here.

Frederick Albright, Estrella, San Luis Obispo County.—My yellow millo maize is doing rather poorly, but I shall get seed enough to give it a further trial. My cow won't offer to eat the fodder.

D. M. Dimmick, Carpenteria, Santa Barbara County.—Yellow millo maize has done remarkably well, much better than white millo maize. It can be cut here about three times in the season. It is very valuable on land a little too dry for alfalfa, and it makes much better flavored butter than alfalfa.

Wm. Lockstone, Jamul, San Diego County.—The yellow millo maize matures in good season.

JOHNSON GRASS, OR EVERGREEN MILLET—SORGHUM HALEPENSE.

This plant was widely distributed throughout the State about ten years ago, both by dealers and public institutions. Our report for 1885–6 contains quite an extended review of the plant, and a large number of

reports from those who have grown it experimentally. Opinions are at variance as to its value, except that all who have experienced its intrusion upon cultivated ground denounce it as an unmitigated pest and a grievous burden, because efforts at its eradication are difficult and expensive. It cannot be denied that, on the whole, the State would be much better off if it had never been introduced. It is so susceptible to frost, and so sure to die out in dry waste places where its presence might be desirable, that its worthlessness as a dry-land plant must be conceded. It is so tenacious and difficult to root out on lands kept moist by cultivation, or on those naturally sub-irrigated by seepage water from natural or artificial watercourses, and so prone to spread on irrigated lands by carriage of seed in irrigation water, or by distribution of the roots by plow or cultivator, that it is denounced in unmeasured terms by those seeking to use such lands for orchard, vineyard, or field crops.

Very expensive work has been undertaken in the eradication of Johnson grass. Some have extirpated it by actually digging out, hauling away, and burning every particle of root which could be found from surface to hardpan, and afterwards watching for and repressing it at each subsequent outcropping. It is doubtful if such heroic treatment is necessary, providing one will undertake systematically and unremittingly a surface treatment. If the roots are thrown up to sun and air at the time of the year when the soil and air are driest and the heat most intense, the furrows being left standing on edge as much as possible, the roots can be gathered by harrowing after drying out, and burned. After disposing in this way of as many as possible, the aftergrowth can be repressed by working the ground over about once a week with a cultivator with flat, sharp teeth; this should be done at stated intervals, whether the grass makes much show above the surface or not. In fact, the success of the method depends upon never allowing the plant a glimpse at the light. If it be allowed to make a top growth before using the cultivator, then each cultivation will but enable it to more quickly recover the ground by distributing its roots, but cutting it continually below the surface will finally exhaust and kill out the roots. This is the method which gives best results in the extirpation of the wild morning-glory, and no aerial plant can withstand such treatment. It must, however, be pursued for a period long enough to accomplish the results, and not taken up spasmodically or stopped too soon. On drier, heavier soils the plant can in many cases, no doubt, be killed out by very little treatment after the dry plowing first mentioned.

As to the value of Johnson grass as stock feed there is some difference of opinion, arising, to some extent at least, from the stage of growth at which different growers have used it. It is undoubtedly acceptable to animals when the growth is young and succulent. It is also readily eaten when growing with alfalfa, and it is believed to obviate bloat, which is common among animals turned into alfalfa fields.

The following extracts from our correspondence relative to Johnson grass is supplementary to that published in our report of 1885–6, to which allusion is made above:

Wm. H. Mullen, Big Bend, Butte County.—The evergreen millet roots never amounted to much. It is living yet, but not growing or spreading as it should. It is in a very dry place.

Eugene Melvin, Paradise, Butte County.—The *Sorghum halepense* roots, even in shallow soil, were unhurt by the cold of winter. It keeps green all summer on dry, shallow soil,

if kept pastured or cut; otherwise it goes to seed, and dries up in the fall, but comes again from the root in the spring. I find some difficulty in getting it to grow from the seed. The seed comes up so late in the spring that the plants are not strong enough to stand the first summer heat. It has never failed to grow with me when the roots were planted. I have broken them three or four joints in a piece, scattered them on the ground, and then plowed them under, with very satisfactory results. I have never seen horse or cow refuse to eat it. The pigs eat both roots and leaves, and the chickens eat the seed. I am well pleased with it as a summer forage plant for dry, shallow soil. I have not tried curing it for hay.

James Hodge, Hanson, Humboldt County.—The evergreen millet all died.

E. L. Reeves, Willits, Mendocino County.—Evergreen millet is a late grass, with rather coarse leaf and stalk. It bears a large amount of fine seed. Sown in April the seed is not yet ripe (September). On grain hay land I think it would yield a heavy crop of hay or make green summer pasture.

R. C. Marsh, Glenbrook, Lake County.—I have tried evergreen millet, but it will not stand the cold.

C. C. Reynolds, Kelseyville, Lake County.—The evergreen millet lives and grows well without water on our high upland, but it is not desirable for my purpose, for the reason that it is so easily killed by frost, and stock are not fond of it.

Joseph Chrisman, Lower Lake, Lake County.—I planted roots of the evergreen millet on different soils. All that was planted on cultivated land grew and is growing yet, notwithstanding I have plowed the ground two or three times since, which only caused it to come up thicker. It seems to be excellent food for all kinds of domestic animals. It is as easily bitten down by frost as corn, though it will grow right up again in the spring. I also sowed some of the seed on a very dry sidehill, which also grew all summer; but the land was unprotected from rabbits, and they dug it out and destroyed it.

Wm. H. Hilton, Glen Ellen, Sonoma County.—The evergreen millet roots were planted on a hillside, eastern exposure, on adobe soil. They soon died out.

A. W. Edwards, Los Gatos, Santa Clara County.—Would note among valuable forage plants the evergreen millet as remarkably thrifty in loose soil, and when once rooted it is *very* hard to get out. It is eaten readily by stock.

L. L. Guss, Wrights, Santa Clara County.—I find it almost impossible to kill out the evergreen millet, and think it might make fair pasture after cattle get used to it.

F. H. Babb, hills east of San José, Santa Clara County.—Evergreen millet is a troublesome weed in orchard or cultivated land, but disappears in uncultivated pastures.

S. R. Smith, Diamond Springs, El Dorado County.—We sowed the "Johnson grass" in a very wet bottom with clover, and it has done very well. The horses are very fond of it, although a strong wiry plant.

Henry Murphy, Cramer, Tulare County.—For two years I have grown the evergreen millet on a small scale. I like it; it does well with me. Stock of all kinds like it. Horses, cattle, hogs, and chickens relish it. It will make two crops a year, and furnish plenty of feed for hogs during winter.

A. C. Athearn, Alpine, San Diego County.—*Sorghum halepense* is a failure in this vicinity. Frost does not kill it, but it does not yield enough and is too coarse and woody.

C. S. Babbitt, El Paso, Texas.—Johnson grass is splendid for cows; makes sweet milk and butter, and makes good hay. It is easily and cheaply started, and stands the drought better, and yields a greater amount of feed per acre than alfalfa, and the milk of cows fed on it lacks the clover taste which alfalfa imparts. But it has one terrible drawback: we can't, as yet, control it; can't kill it out. The seed floats down the ditches; birds carry it; a little bit of root on the point of the plow, all serve to give it a start in a new place. And what promised to be of such value in this dry soil of the Rio Grande Valley, where nothing grows without irrigation, seems to be about to master us. It may die out, if not irrigated, but it will not do so in one year.

ESPARCETTE, OR SAINFOIN—ONOBRYCHIS SATIVA.

This clover has attracted much attention in this State during the last three years, because of widely circulated reports of its success on dry lands in the State of Nevada. We have grown it continuously in our experimental plots in Berkeley for the last twelve years, but have never seen reason to form a very good opinion of it. Our soil in Berkeley is, however, of an adobe type, and our climate cool from proximity to the bay of San Francisco. As the region from which its notable success was reported was one of light, dry soils and high summer heat, conditions which have always been considered desirable for the growth of sainfoin in European countries, we surmised that our unfavorable opinion of the plant was due to lack of adaptation in our conditions. To determine this point, and to give our correspondents opportunity to test

the plant which was so highly praised, we furnished seed to many applicants during the winter of 1889. Their experience, which will be outlined below, indicates that the plant has been greatly overpraised, or perhaps that too wide application has been made of the experience of some growers who enjoyed exceptionally favorable conditions. There are, however, indications in the reports that this clover may prove very satisfactory, locally, under suitable conditions. Records of experience covering longer periods are necessary to determine definitely the standing of the plant in California:

Peter Klink, Berryvale, Siskiyou County.—The forage plant called sainfoin, received four years ago, is still growing, but it only attains a height of about nine inches here, at an elevation of three thousand five hundred feet, at the foot of Mount Shasta. I think the seasons are too short.

Thomas Dickinson, Yager, Humboldt County.—Esparcette was killed by the summer drought, the worst I have seen here in the hills for sixteen years.

George Bates, Brownsville, Yuba County.—Esparcette, sown in April on dry soil, lived through the dry season, and seems to promise well. Where it was irrigated it did not do as well as red clover.

C. W. Hatcher, Yolo, Yolo County.—The esparcette seed was sent to a friend in Anderson Valley, Mendocino County, who writes that it came up well, grew remarkably well, and produced an abundance of hay.

R. C. Marsh, Glenbrook, Lake County.—I tried sainfoin last spring (1888), but only a few seeds grew, and they have all disappeared.

J. M. Addington, M.D., Bartlett Springs, Lake County.—Esparcette does nothing with us as expected. With irrigation it only attained a height of fourteen inches, while alfalfa was three feet. The alfalfa was cut three times, while the esparcette, after the first cutting, grew but eight inches, when frost came and stock was turned upon it.

Frank Owen, Zem Zem, Napa County.—My experience with esparcette leads me to believe it inferior to alfalfa. It needs the same soil and climate to perfect it, and it will not thrive upon dry hill pastures.

Thomas J. Pilkington, Trenton, Sonoma County.—Esparcette sown in the spring in connection with orchard grass on a bush-burn in the ashes, did not grow, but the orchard grass made an extremely good stand.

John Marshall, Sebastopol, Sonoma County.—Esparcette was sown on good ground in good order and well harrowed in. About one fourth of the seed came up, and grew during the summer to be about two inches high and the same in breadth. I think it does not suit this region.

E. H. Cheney, Smith's Ranch, Sonoma County.—I have tried esparcette clover on my land where the bedrock came within one foot of the surface. The seed was sown in March. It has made about eight inches growth, and is, at this writing (September 16th), growing, and is as green as grass in the spring. If it is a good forage plant, and will stand such a severe test as I have given it, it will be valuable.

J. M. Benson, Elliott, San Joaquin County.—Esparcette did very well at first, but I do not think my land is adapted to it, as it is inclined to bake and crust.

John H. Eden, Nevada City, Nevada County.—Esparcette and alfalfa, in adjoining patches, were covered with hail, in May, which stood on the ground about thirty-six hours, and killed both plants.

C. W. Meade, Pescadero, San Mateo County.—I made two sowings of esparcette—one in January and one in May. That sowed in January grew a little over two feet high, and bore seed twice—once in August and again in October. It was sown on a loose, black soil, that was covered with hazel brush two years before. The sowing in May was made on black loam, near the cow corral, very rich and very foul. It was sown in drills, and was hoed once. Few of the plants bore seed, but it made a big root growth. The taproots were from one foot to over two feet in length.

M. Gorman, San Ardo, Monterey County.—I got a pretty good stand with esparcette on a high, dry hillside about three hundred feet above the level land. Some stalks grew about nine inches high, bloomed, and ripened some seed. It appears to be good for dry hillsides where nothing else will grow.

J. B. Sayler, Bryson, Monterey County.—Esparcette has not done well with me, though sown on good land.

R. S. Potter, Arroyo Grande, San Luis Obispo County.—We got but one plant from a large sowing on loose, sandy soil, but it made a medium growth and remained green all summer.

George Weiss, Creston, San Luis Obispo County.—Esparcette, sown on black sandy loam in April, kept green until September, and then started again after the fall rains. But I have concluded, after four years' experience, that esparcette is not a success with me as a perennial forage plant. It grows well the first year as long as the ground is loose, but when the soil is hardened by heavy winter rains the plants gradually die out.

E. R. Pierson, Raymond, Fresno County.—Esparcette made a good growth on dry sandy loam, and went to seed, but contrary to my expectations the roots died.

E. S. B. Dunbar, Goshen, Tulare County.—Esparcette grew to a height of eight inches,

when grasshoppers came on and ate the leaves and stalks, and started in on the "button," which appears at the surface of the ground. This killed the plants.

James Nash, Stuart, Santa Barbara County.—I planted esparcette in eight places. It came up only in one spot, and then died.

C. J. Harris, Santa Paula, Ventura County.—I and my neighbors have tried esparcette, sowing it on well-prepared gravelly land, where trees and vines do well. It did not all come up, and that which did come up amounted to nothing.

J. F. Duehren, Acton, Los Angeles County.—Three neighbors and myself tried esparcette two years in succession without success—but few seeds germinating. Our land is very high and dry.

P. B. Litton, Elsinore, San Diego County.—Esparcette, on sandy loam upland, promised well, but eventually thinned down to a few plants, which I hope to preserve, as I am inclined to believe it may prove valuable in this locality.

Mrs. L. S. Cleland, Mesa Grande, San Diego County.—Esparcette grew well on a loamy hillside, until burned up by the unprecedented hot spell of July.

S. J. Irwin, Nuevo, San Diego County.—The esparcette grew well from the seed, and is the most beautiful clover I ever saw. Chickens eat it down to the very root.

Al. Fielding, Santiam, Linn County, Oregon.—Esparcette sown in February grew feebly, and half died out during the summer, but the plants which survived revived after the fall rains. I believe early sowing is necessary to get a good summer's growth.

SNAIL CLOVER—MEDICAGO TURBINATA.

This plant is a native of southwestern Spain, and in its introduction and distribution we have hoped to secure for the State another plant as valuable as its botanical relative "burr clover" (*Medicago denticulata*). The snail clover has a smooth pod, which cannot attach itself to the wool of sheep or hair of goats as does the toothed burr of burr clover. This pod is more than twice the diameter of the latter. The growth of the snail clover resembles that of burr clover, but with us it is much ranker. It starts from the seed as soon as the earth is moistened by the fall rains, and makes a strong growth during the winter and spring, drying up as soon as its vast crop of seed pods ripens early in the summer. It volunteers freely from these seeds, and thus repeats itself from year to year. The letters below show that some experimenters have probably been misled by this summer disappearance of the plant, to the conclusion that it does not succeed. Others doubt its self-maintenance when grazed. This point must be determined by longer observation. We question whether it will prove less tenacious than burr clover, although the larger pod renders it more readily gathered. As for tearing open the pod and sowing the clean seed, as one correspondent recommends, we have never seen occasion for that. It seeds freely with us without even covering the pod with earth, and we presume it will do the same wherever burr clover will do it.

The following reports cover nearly the whole State, and the preponderance of the evidence is strongly in favor of the plant. It is evident that its growth will be freest and most satisfactory where moisture is abundant, and that in exceptionally dry and hot situations its growth may be small and the plant of little account. It also shows liability to frost-injury in some localities; we think, however, that the following testimony warrants its trial by those who have not yet had opportunity:

Charles Foulke, Maple Creek, Humboldt County.—The snail clover did well, although it was slow in starting.

C. R. Gabeler, Englewood, Humboldt County.—The snail clover came up and made a fine, early growth, but the seeds are so large I fear stock will eat them entirely up so that it will never seed itself. It soon died down on this soil.

Jackson Sawyer, Table Bluff, Humboldt County.—About one half of the snail clover seed grew. It made a very rank growth, and produced about a half bushel of seed. Cattle eat the dry seed stalks well. I do not know how the ground can be seeded with it. For field culture it would not be practicable to pick the seed by hand.

R. E. Mason, Bridgeville, Humboldt County.—I planted the snail clover seed on a dry

knoll and took no care of it after planting. I gathered a half gallon of seed. I think it will do well here, if it does not need to be sown every year. It all died out.

Leslie Hoag, Boonville, Mendocino County.—The snail clover grew rank in the garden and produced a large amount of seed-balls. I will try it on a range next season.

W. R. Gaine, Point Arena, Mendocino County.—The snail clover does not do well here; the climate is too cold, I think. It was planted on a high, dry, sandy loam, and it came up all right, but the plants were puny and small.

Mrs. Stephen Kempster, Cuffey's Cove, Mendocino County.—The snail clover grew very well. I think it is more suitable for low wet places than for hilly land. It was planted in a loose sandy soil with plenty of water.

A. Requa, Cahto, Mendocino County.—The snail clover grew high enough to mow, and will prove valuable for this part of the country. I saved a couple of gallons of burrs.

E. L. Reeves, Willits, Mendocino County.—The snail clover did not come up very thick, but that which did come up made a fine growth. It bears a large amount of seed and ripens pretty early. I think it would make good pasture, but would not do for hay, as it lies close to the ground.

J. H. Adams, Occidental, Sonoma County.—Snail clover, planted May 10th in rich, sandy soil, made a growth of about fifteen inches, kept green quite late, and was very full of seed burrs, which were very large. I think this will be a fine feed.

A. Van der Naillen, San Francisco.—The snail clover was planted on hill land in Napa County and received only one good rain. It was almost a failure, still the five or six plants gave a great many burrs or snails.

Fred. Scharr, Red Bluff, Tehama County.—Snail clover does here as you say it does at Berkeley.

C. F. Shelton, Bangor, Butte County.—Snail clover is killed out on dry, baked soil.

Eugene Melvin, Paradise, Butte County.—A little of the snail clover matured seed, but the plants grew only a few inches high. It was planted in February in good soil.

Benj. Sanford, Smartsville, Yuba County.—The snail clover this summer does not surpass our burr clover.

Geo. Heintzen, Brown's Valley, Yuba County.—I sowed the snail clover on February 13th on good loam soil. It came up nicely and grew, but was stunted by the dry season. It was about eight inches high when it succumbed to the drought. I think it is superior to our burr clover, as the seeds are smooth. I should like to have tried it in the fall.

R. S. Alderman, Smartsville, Yuba County.—The snail clover was sown near the irrigating ditch, and grew somewhat thriftily, but did not prove equal to the burr clover, which is at home hereabouts.

Joseph Clark, Anthony House, Nevada County.—The snail clover was taken by the birds as fast as it came up, with the exception of five or six plants, which matured. I think it will be of no value in this vicinity.

J. W. DeLameter, Newcastle, Placer County.—Snail clover grows, but not well, without irrigation. It grows well in winter, and makes a good growth of about one or two feet.

M. F. Gregory, Jenny Lind, Calaveras County.—Snail clover did well on bottom land badly sanded from mining debris. It produced much seed, which volunteered finely, making good feed in December.

Fred. Greve, West Point, Calaveras County.—The snail clover did well.

Raymond Plasse, Jackson, Amador County.—The snail clover grew nicely. I gathered about a half bushel of seed. I think it will be a good pasturage for our hills—a good feed for sheep and cattle.

E. W. Maslin, Pino, Placer County.—Snail clover produced moderately well on unirrigated granitic land.

B. B. Hogaboom, Franklin, Sacramento County.—Snail clover promises to be very valuable for feed where frost is not severe. It seems quite susceptible to frost.

A. B. Harrison, Danville, Contra Costa County.—The snail clover, planted in my nursery, grew well and produced considerable seed for future use. The plants have died down.

Oscar Smith, Brentwood, Contra Costa County.—The snail clover seed nearly all grew. The plants were about one foot high and full of seeds, but they died early. I think it will do well here when we have more rain.

Howard Overacker, Centerville, Alameda County.—Snail clover sown on hilly land grew rankly, and ripened seed in July. It looks like the common burr clover, except that the plant is three times larger, and has a large, smooth burr. It is better than common burr clover, as cattle can pick up the seeds more easily.

L. L. Guss, Wrights, Santa Clara County.—The snail clover did not make nearly so rank a growth as burr clover on the same soil.

Hyatt Hibbard, Paso Robles, San Luis Obispo County.—The snail clover planted February 27th, and kept well cultivated, ripened a fine crop of seed about June 20th.

Linwood Palmer, Arroyo Grande, San Luis Obispo County.—The snail clover yielded from one *single seed* (not a burr) two hundred and thirty burrs on cultivated ground. The ground is heavy, clay and adobe, and the clover does not easily propagate itself. The burrs should be torn open and the seed planted to insure growth.

E. S. B. Dunbar, Goshen, Tulare County.—Snail clover came up well and seeded freely.

Wm. Walker, Olancha, Inyo County.—The snail clover was a complete failure. Perhaps I gave it too much water.

William Oliver, Bishop Creek, Inyo County.—The snail clover came up pretty well, late in the spring. After reaching six inches in height, it did not grow any during the warm weather; however, it spread well over the surface; but now (September) it has made a growth of four feet. I think it will flourish on this sandy land as well as alfalfa.

Walter L. Hall, Nordhoff, Ventura County.—Of the several forage plants received, snail clover alone did well on the light, gravelly loam of a steep hillside, where I planted them in February. It produced double the seed sown, and will probably do much better by earlier sowing.

P. B. Litton, Elsinore, San Diego County.—Snail clover has done well on sandy loam upland soil.

H. H. Gird, Fallbrook, San Diego County.—Snail clover is too susceptible to frost to do well on bottom land.

John Hudson, Escondido, San Diego County.—The *Medicago turbinata* did not do well.

Wm. Lockstone, Jamul, San Diego County.—The snail clover did well, and has excited considerable interest.

BLACK MEDIC—MEDICAGO LUPULINA.

This clover, which is also called "yellow trefoil," grew so well without irrigation on our grounds, seeded itself so freely, and in fact appeared here and there at a distance and grew so thriftily even in what seemed to be most unfavorable situations, that we distributed the seed with the expectation of disseminating a very valuable wild pasture plant. This seems, in truth, to be its character in regions suited to its growth, but its requirements are apparently rigid, and we can recommend it only for upper coast regions. The interior of the State and even valleys on the east side of the Coast Range, south of San Francisco Bay, seem to be too dry and hot for it. Even in regions well adapted to its growth it will prove most satisfactory on moist, retentive soils.

The experience reported by the grower in Nevada is rather surprising, but probably would be more intelligible with a better knowledge of local conditions:

Eugene Melvin, Paradise, Butte County.—Some of the black medic seed was scattered during the heavy rains in January, to compare it with the native grass, but none of it ever came up. Some, sowed in good soil in February, came up after a month's delay, and grew very slowly. It blossomed, but dried up in the hot weather of April.

R. E. Mason, Bridgeville, Humboldt County.—The black medic I planted on a dry piece of ground, and it has done remarkably well. It seemed to die out this fall, but since the rain it has started up again and looks fine. It did not go to seed.

C. R. Gabeler, Englewood, Humboldt County.—The black medic has made a slow growth. I have not been able to cut it, but as it is still growing (September 20th), and should it come on after the early rains, I should think it a valuable plant, although I am unable at the present time to pass judgment on it.

Mrs. Stephen Kempster, Cuffey's Cove, Mendocino County.—The black medic came up and died right down. It was planted in loose sandy soil, well watered.

E. Whittington, Middletown, Lake County.—The medicago came up well, but has been so cropped down by the rabbits that we cannot judge of its growth.

Adolfo Bloom, Petaluma, Sonoma County.—The black medic grew finely.

Joseph Clark, Anthony House, Nevada County.—The black medic I tried in three different places. One patch I spaded up, another I planted where some brush had been burned, and the third was planted on a piece of rather poor land. Part of the seed I planted on January 28th, and the rest I sowed two weeks after. The first and third pieces came up, but were destroyed by the insects. The second piece, where I burned the brush, came up and appeared to do well until the first of May. It then dried up and died, apparently for the lack of moisture.

E. W. Maslin, Pino, Placer County.—I have not succeeded in growing black medic on unirrigated granitic soil, though I have tried it twice.

Raymond Plasse, Jackson, Amador County.—The black medic did not grow at all. The hot season was very severe.

H. W. Turner, Valley Springs, Calaveras County.—The black medic was planted in red foothill soil. With no irrigation it came up and grew well, but did not stand the unusually dry season.

Fred. Greve, West Point, Calaveras County.—The black medic made a fair growth.

Frederick Albright, Estrella, San Luis Obispo County.—My main bed of black medic is cut to the very roots by "jack rabbits," after putting a good many kinds of things on it to keep them off. It appears to grow pretty well. I have a few tufts of it in other places. Some of it bloomed, but the heat and dry weather, with no spring rains, are against it here.

William Oliver, Bishop Creek, Inyo County.—The black medic came up late in the spring, and did not do well during the summer; but now (in September) it has made a growth of four feet.

W. H. Frink, El Casco, San Bernardino County.—Black medic, sown in March on dry, sandy loam, made but a scattering and weak growth.

M. E. Spafford, Hardin, Crook County, Oregon.—The black medic was sown on alkali ground. It never did any good.

Cyrus Smith, Wellington, Nevada.—Black medic, sown on dry upland, and irrigated till the plants got a good start; grew afterwards for three months during the driest part of the season, with but one irrigation. It showed no signs of drought, but grew finely the whole season. I think it the finest forage plant I ever saw, remarkably adapted to a dry climate. It has a flavor which seems to be acceptable to all domestic animals.

JAPAN CLOVER—LESPEDEZA STRIATA.

This plant seems to be a conspicuous failure under California conditions. It is exceedingly hard to get anything of a stand of it, and it dwindles and disappears early in the summer, making no provision, apparently, for its reappearance. Present information, after several years' sowing on our grounds in Berkeley and reports from other California situations, leads us to pronounce it worthless. If any California reader of this report should have found it otherwise, we would like to know it:

F. F. Barss, Placerville, El Dorado County.—I did not give the Japan clover, *as I think*, a fair trial, as my farm had been cleared but a short time.

A. C. Davenport, Stockton.—The clover came up very scattering, and didn't do well.

Benjamin B. Hogaboom, Franklin, Sacramento County.—I do not think that the Japan clover will amount to anything on unirrigated land, as it is too dry for it.

F. Femmons, Gertrude, Fresno County—Japan clover grew well during the summer. In the fall the stock did not touch it, having alfalfa and Schrader's brome grass in the same pasture. During the winter the cold weather killed the Japan clover.

Henry Murphy, Cramer, Tulare County.—The Japan clover failed to grow well. Only a few seed came up, and at this writing (September) looks sickly.

W. E. Willey, Oakland, Mason County, Washington.—The Japan clover was planted on dry gravelly soil. It has made only a small growth, and has not blossomed yet (September), but it is still green. It would do better on better soil.

TANGIER PEA—LATHYRUS TINGITANUS.

This plant belongs to the "sweet pea" class, not to that of the common garden pea, and yet it yields a seed which, cooked as peas usually are, is very desirable for table use. It is the fact that the plant itself is liked by cattle that led us to distribute it. Such distribution was first made in 1889, and sufficient time has not elapsed for full data on the subject; but at present we are very favorably impressed with its growth and possible value as a forage plant in some situations. As a native of Barbary, it should be inured to heat and drought, and it has shown here its hardiness under low temperatures. An effort will be made to secure wider trial of it.

George Simmons, Yreka, Siskiyou County.—The tangier pea, sown in rows about three inches apart, is a very good forage plant, and yields abundantly.

C. W. Griffin, Newville, Colusa County.—The tangier pea is very productive.

J. M. Addington, M.D., Bartlett Springs, Lake County.—Tangier peas grew and bloomed all summer and fall, and lived through two snow storms and plenty of freezing. They matured no pods.

M. Gorman, San Ardo, Monterey County.—Tangier pea grew only about two inches high; had a few sickly blossoms but no fruit.

H. H. Gird, Fallbrook, San Diego County.—The tangier pea is probably too nice, as the birds eat up vines and all. They grow thriftily.

TAGASASTE—CYTISUS PROLIFERUS ALBUS.

Reference was made to this plant in our report for 1885–6, and it was stated that under favoring conditions it had become a tall shrub with hard, woody stem and branches, and quite different from what we expected from Von Müller's description of it as a "tall herb." If subjected to browsing by stock, it would, no doubt, make a more scrubby and lower growth, but it can hardly be considered as a forage plant in the usual acceptance of the term. For dry mountain lands it might be valuable as browsing, but experience, thus far, seems to indicate that it is too much injured or repressed by heat and drought, and too susceptible to frost to be generally valuable on wild pastures. Very many of our native shrubs are probably better than it, and could be more profitably propagated. But, as a rule, we do not desire to increase the brush growth, but to introduce something more productive and satisfactory. For the above reasons we conclude, from present knowledge, that tagasaste has no particular value in this State. The following are extracts from correspondents:

George Bates, Brownsville, Yuba County.—Tagasaste sown in April, and watered, grew to nine inches in height by September. Sown on dry land it germinated well, but perished from drought afterwards.

Leslie Hoag, Boonville, Mendocino County.—Only one seed germinated. The plant is two feet high. I don't think it is of much value to this section, as we have too much brush already.

J. R. Stokes, Boonville, Mendocino County.—The forage plant, tagasaste, did well. We have a native forage plant very much like it.

E. W. Maslin, Pino, Placer County.—I have not succeeded in growing tagasaste on unirrigated granitic land, though I have twice tried it.

Raymond Plasse, Jackson, Amador County.—The tagasaste germinated a few seeds, but they died in the hot summer.

H. A. Messenger, Valley Springs, Calaveras County.—I planted some of the tagasaste seed at different times and in different places, following instructions relative to scalding and sprouting. Those which I planted in the field I put in places where the fire had burnt brush piles, so the grass and weeds would not interfere with their growth. After digging the ground well and planting the seed, I covered with brush, to protect the small plants. Although there was no late rain after the seeds were planted, some of them came up and have done well without a drop of water, and I think, so far as I can see, that it will be a valuable addition to our forage for stock in the dry foothills. I notice the rabbits have topped nearly every one of them, which shows that they appreciate them.

Fred. Greve, West Point, Calaveras County.—The tagasaste did well.

H. W. Turner, Valley Springs, Calaveras County.—The tagasaste was planted in red foothill soil. With no irrigation it came up and grew well, but did not stand our unusually dry season.

R. Ship, Arroyo Grande, San Luis Obispo County.—The tagasaste plants are not growing well in new ground. The tallest is about two feet high.

N. F. Frick, Paso Robles, San Luis Obispo County.—Tagasaste has grown the first summer to a height of about five feet and very bushy.

H. H. Gird, Fallbrook, San Diego County.—Tagasaste seems to be injured too much on bottom land by frost to be of much account in such situations.

JERSEY KALE.

This is a tall-growing collard, the seed of which was brought to us from the island of Jersey by Mr. S. Wakeham, of Berkeley. It is largely grown on Jersey for cow feed. On our grounds in Berkeley it has produced green feed at the rate of sixteen tons to the acre, starting again quickly after cutting. Judging from the reports of some of our correspondents, and the superior height which the plant attained with them, the weight of green fodder produced must be much greater than our figures. The plant has also shown a much wider range of adaptations than we expected. We did not anticipate success with it, except on moist lands and in regions of moderate heat. It seems to have over-

stepped both these limitations, and it commends itself quite generally as a source of vast quantities of succulent forage during the dry season. Whether it will thrive on scant cultivation, such as too often is given to large areas of any plant, we are not assured, for we imagine that most growers have thus far given it something like garden culture. For the family cow and for poultry it seems preëminently fitted to give, perhaps, more green fodder than can be secured with any other plant on the same area. The following extracts from correspondence show the wide range of the plant, and some of its habits of growth:

Thomas J. Pilkington, Trenton, Sonoma County.—Jersey kale on moderately enriched soil is a success. It furnished all the green feed I needed for my ducks and chickens, which eat it greedily even when not confined. I shall grow it largely for poultry.

Isaac Lea, Florin, Sacramento County.—The Jersey kale grew splendily on my marsh land at Napa Junction.

Howard Overacker, Centerville, Alameda County.—Jersey kale was sown in a warm, rocky place in the hills back of Mission San José. It has grown well, being five feet high in the middle of December. Stock seem to like it.

A. L. Bowden, Bitterwater, San Benito County.—Jersey kale, sown April 15th, had grown to five or six feet high by the last of October without any irrigation. We consider it excellent for poultry. All kinds of stock eat it well.

M. E. McCormick, Easton, Fresno County.—Jersey kale grew to a height of eleven feet and made most excellent green feed for fowls.

E. H. Cawley, Starkey, San Luis Obispo County.—Jersey kale did well, and, after cutting, started again, and was two feet high at Christmas. I never saw anything more vigorous.

N. F. Frick, Paso Robles, San Luis Obispo County.—Jersey kale produces more feed from the same area than anything else we have grown.

H. Brundage, Montecito, Santa Barbara County.—Jersey kale has made a heavy growth. It still grows well after cultivating twice, and I think it will make an excellent forage plant.

J. R. Giddings, Pasadena, Los Angeles County.—Jersey kale grew to a height of five feet. Stock eat it readily, but it requires more attention than sweet corn, and I do not think it is so good.

S. J. Irwin, Nuevo, San Diego County.—Jersey kale, sown in rows, on pretty dry land, grew slowly, but lived all summer, and when the fall rains came it fairly ran up. After cutting it makes another head of leaves, and will yield enormous crops of forage if watered and manured.

Edwin Haffenden, Lakeside, San Diego County.—Jersey kale grew well without water, while Japanese wheat grass grew but little, because of drying out.

W. H. Frink, El Casco, San Bernardino County.—Jersey kale, sown in March, on moderately moist land, made a moderate growth without water.

SALT BUSHES—ATRIPLEX SP.

These Australian plants have been grown and distributed by this Station for the last ten years, and they are characterized, so far as the species have been determined, in our report for 1885–6. Correspondents do not say much about them, and the inference would be that they do not serve such good purposes here as accounts credit them with in Australia. On the grounds in Berkeley they grow thriftily without irrigation, but the forage does not seem to be relished by stock to which we have offered it, possibly because the animals are too well fed otherwise. We have made distribution with reference to a possible value in them as feed for sheep and goats, but reports do not include any testimony on this point. The following are the only reports returned to us:

John Güttinger, Pescadero, San Mateo County.—I found the salt bushes very useful when I was in Australia.

B. B. Hogaboom, Franklin, Sacramento County.—The four kinds of salt bushes sent me grew well during the driest part of the year, but were cut down by winter frosts.

M. F. Gregory, Jenny Lind, Calaveras County.—I planted the salt bushes on bottom-land badly covered with sand from mining debris. They grew well, though grievously set back by rabbits. Two kinds bore seed, and volunteer plants grew in abundance. One kind seemed very attractive to fowls, which relished the small red berries produced by it.

REPORTS FROM MISCELLANEOUS PLANTS SENT OUT FROM THE CENTRAL STATION.

By CHARLES H. SHINN.

The statistics of the work of the Central Station in sending out plants, seeds, cuttings, scions, etc., receive mention elsewhere in the departmental reports. But the nature and extent of some of the more important distributions, as illustrated by letters from experimenters in various parts of the State, justify the following detailed account. It contains many allusions to the outlying stations, but it is essentially illustrative of the work of the Berkeley station, where the propagating houses are situated, and all correspondence is conducted.

SEEDLING DATE PALMS.

Reports received during the year from those who have planted the date palms vary greatly in character, as will be seen by the following extracts, which refer to seedlings of the true date (*P. dactylifera*) grown and sent out from the Berkeley station:

Zenas Freeman, Fallbrook, San Diego County.—Though received in poor condition, from delay in shipment, they have grown several inches.

William Lockstone, Jamul, San Diego County.—The palms are doing well, but grow very slowly.

Robert Hansen, Anaheim, Los Angeles County.—The palms did not make much headway.

Thomas Spencer, Anaheim, Los Angeles County.—The palms are healthy and making good growth. They were not in the least affected by the cold.

Richard Robinson, Nordhoff, Ventura County.—The palms have as yet made no new growth, but look healthy, and I have no doubt they will succeed.

H. Brundage, Santa Barbara.—The two palms look well, but have made but little growth.

Frank Dana, Nipomo, San Luis Obispo County.—One arrived dead. The other has done very well, and seems to be at home; it has grown about ten inches. I have also planted the seeds of dried dates, which seem to be doing equally as well.

R. Ship, Arroyo Grande, San Luis Obispo County.—Both of my tree palms are alive, but apparently have not grown any.

Mrs. E. Burk, Mountain View, Santa Clara County.—The two palms did not take kindly to the winds at first, their leaves were so fragile; but seem now (September) to be getting acclimated. Though no higher, they are sending more leaves out, and I have hopes that they will make their homes with us.

E. J. Delaney, San José, Santa Clara County.—The palms I potted are doing very well, though they have not made much growth. I will put them out in the fall.

Mary I. Gates, Mountain View, Santa Clara County.—The two palms, which I planted out in the open ground, are looking very thrifty.

Samuel Swift, Oakland, Alameda County.—One of the palms lived, and has exhibited much hardiness.

A. B. Harrison, Danville, Contra Costa County.—One palm is growing tolerably well. The best specimen was destroyed by a gopher.

J. W. Stitt, M.D., Vacaville, Solano County.—They have all grown well. I have four. One is about four feet high. The soil is quite sandy.

F. Spangenberg, Cupertino, Santa Clara County.—I gave them special attention. One was watered, the other was not. The watered one nearly died. I withheld the water, and it has since improved in appearance. The other has done much better, made several leaves and looks healthy, although it has not made any growth to speak of.

Mrs. C. M. Vincent, Lockeford, San Joaquin County.—Though the tops of the date palms were killed by the frost (of January, 1888), yet the trees are sprouting from the roots.

Nicholas Flanagan, thirteen miles northwest of Orland, Colusa County.—One of the date palms is growing slowly but surely.

Fred. C. Miles, Penryn, Placer County.—The date palms have bulbs four times the size at time of their receipt.

J. W. DeLamater, Newcastle, Placer County.—The palms are alive and doing well; about one inch growth for the season.

Mrs. N. C. Alley, Roseville, Placer County.—One of the date palms is living. In regard to their adaptability to this climate, I cannot state. I have lost many other much more hardy shrubs.

Previous reports have given information about trees now growing in various parts of the State, and two seedling varieties have been fruited at Winters and elsewhere, and exhibited at horticultural fairs. As an ornamental lawn or avenue tree, the date palm (including the Canary Island species, *Phœnix Canariensis*) has a much wider range in California than has been ordinarily understood, and sooner or later it will be planted extensively for these purposes as far north as the head of the Sacramento Valley.

It may be gathered from these widely scattered observations that local situation makes very material difference; but further experiments are required to give definite results. The extracts given above are from only about one fourth of the letters received at this office, but they cover the whole ground. In a year or two more the trees will be fully established, and will grow rapidly. One of the most satisfactory of recent plantings of the date palm for ornament only, is that of Don Juan B. Gallegos, at the Mission San José, Alameda County. He has about fifty large trees of the wild date now beginning to fruit. They stand in grass, and receive constant irrigation. The most extensive planting in Alameda County, however, has been done by John Rock, at Niles, where the date is used for avenues.

THE PERSIAN DATE PALM.

The successful cultivation of the date palm of commerce has long been predicted as among the probable things in California. A short time ago a writer in the New York "Evening Post" urged that there was an opportunity for the investment of capital in date groves in portions of California and Arizona.

During the year 1890 the culture of improved varieties of date palm received considerable encouragement in California. Public interest was first aroused by a valuable importation of named varieties from Persia, the first ever received in the United States; and many letters were received by me from persons who wished to secure plants. The limited number obtained, and also the great importance of the experiment, necessitated the planting of the whole number of dates at the two experiment stations best suited to this tree.

A letter received from Professor Van Deman of Washington, gives all the details necessary about the Government importation of dates, and also of citrons. He writes as follows, under date of October 11, 1890:

I have this day started the imported date trees, mentioned in our previous correspondence, by way of the Southern Pacific Railway. We have been keeping them here about a month longer than was expected, because we found it very difficult to destroy the scale insects which came with the plants from Africa. The Entomological Division has been treating them with kerosene emulsion, and finally a spraying of resin solution. It is now thought that the insects are all killed, but I will warn you to be on the lookout, and if anything of the pest mentioned should appear you will know what to do.

I have sent a full set of all the varieties to the station at Tulare, in care of Mr. Julius Forrer, the foreman. The names of the trees are as follows: *Amhat, Nakleh-el-Pasha, Seewah, Hazaneh, Zeb-el-Abed, Sultaneh, Amreeyeh, Rasheedeh*, and one male plant. Also, *Deglet Nour, Rars*, and *M'Kintichi*.

To the station at Pomona were sent nine trees, being one each of the following varieties: *Amhat, Nakleh-el-Pasha, Seewah, Hazaneh, Zeb-el-Abed, Sultaneh, Amreeyeh, Rasheedeh*, and one male plant. It is not necessary to give you any directions regarding their planting.

There are three varieties of which I had but three plants each, and one set of these went to New Mexico, another to Arizona, which, of course, only permit the sending of one to your State, and I thought that Tulare was the proper place to send it.

I also sent to Pomona a box containing citron trees, which I obtained from Catania, in

Sicily. These are the choicest varieties that could be found there, and were budded at my special order. There are six trees of *Cedro Vero*, which is a variety bearing rather small fruit, but very good in quality; two of *Testa di Turco*, two of *Pereltone*, and two of *Limonziana*, making twelves trees in all. These you will know best what to do with, but I suppose that you will set them out at Pomona and propagate from them.

We think that they are entirely free from insects, as they have been kept under strict watch since last spring.

I have had numerous applications for plants of both the date and citron, but of course it was impossible to supply them, and I have now already turned over several of these applications to you, and will continue to do so. I think the date trees have been wisely placed, both in your State and in Arizona and New Mexico.

One colony of the plants is at National City, California, one at Yuma, Arizona, another at Phœnix, and another at Las Cruces, New Mexico. A few of the tubs contained double plants, or, rather, two plants, and I have thus been able to order a division made in such cases, and these extra plants—four female and one male plant—will be sent to Indio from National City, and placed in the care of the Southern Pacific Railroad there. I know that you will wisely control the distribution of the young plants which may be grown; but in the cases where colonies have been placed in the hands of private individuals, an agreement has been made in writing and properly certified, giving this department entire control of the distribution of the young plants. They have been procured at public expense and are the property of the people, and shall be placed in their hands. Trusting that the plants will reach you in good condition, I am,

Very respectfully,

H. E. VAN DEMAN,
Pomologist.

I was at Tulare Station a few days after the arrival of the plants mentioned. From Tulare I proceeded to Pomona, where the new station was just beginning operations. Mr. K. McLennan, the newly appointed foreman, accompanied me. The dates were received at both stations in fair condition, excepting that the *Deglet Nour* and *M'Kintichi* were almost dying. I investigated the matter, discovering that the plants of these sorts were almost without roots—mere "suckers" planted in red clay. It was to be expected that these would not survive, but by constant attention the foremen of the stations are likely to save the entire importation.

The palms at Tulare are planted in sandy soil southwest of the building. They are set in a circle, with the male plant in the center. A few offshoots can be expected from the larger plants in two or three years. At Pomona the palms are in front of the station building, near the street, and will constitute one of the most striking features of the station.

During the present summer (1891) a fair growth has been made, and the palms can be considered established at both Tulare and Pomona.

THE HUASCO GRAPE.

The following extracts from reports received during the past two years from several seasons of shipments of Huasco grape cuttings will serve to show how widely it has been distributed by the University, and also something of its success:

J. P. R. Hall, El Cajon, San Diego County.—In 1888 I received a couple of rooted vines of the Huasco grape. I planted one of them amongst the cuttings of Muscat of Alexandria in my vineyard, marking the place. This summer (1890) they have borne for the first time. I have just picked some bunches of very nice grapes from them. I cannot distinguish any difference in growth, foliage, or habit between the Huasco and the Muscat. If anything, the Huascos are a trifle smaller and not quite so sweet as the adjacent Muscats. As yet, I fail to see any advantage over the Muscat vine.

Zenas Freeman, Fallbrook, San Diego County.—Although the Asiatic cuttings died from delay in shipment, the Chile raisin grape grew several inches the first year.

A. Keith, Riverside, San Bernardino County.—Four of the Huasco cuttings set out in 1888 grew fairly well. They have not yet fruited.

George Musser, Pomona, Los Angeles County—The grape cuttings all grew except three. I cannot tell much about them until they bear fruit.

Wm. Chappelow, Duarte, Los Angeles County.—All of my Huasco grape cuttings grew. They were planted in sandy soil, and have not made much growth.

H. Ellery, Carpenteria, Santa Barbara County.—Of the ten Huasco grape cuttings only one rooted, and that I transplanted, so I can give no information of any importance, [This in 1889; no later report.]

D. M. Dimmick, Carpenteria, Santa Barbara County.—The Huasco grape first bore in 1887, and remarkably well for the second year from cuttings. It has done well in subsequent seasons, 1889, 1890. The berries are very large; some measured one and one eighth inches in the longest diameter, by seven eighths of an inch across. The flavor is slightly better than the Muscat. The growth of the vine is good.

Geo. Weiss, Creston, San Luis Obispo County.—Of the five Huasco cuttings three remained alive, and these I transplanted in 1889 to the vineyard. In comparison with the Muscats transplanted at the same time, they have made a little better growth.

E. K. Thoits, Nipomo, San Luis Obispo County.—The Huascos have done well. Three fourths of them started, have made good growth, and are now bearing.

Mrs. H. McLaughlin, Avenal, San Luis Obispo County.—It was so late when we received the grape cuttings that only the Huasco raisin of Chile grew. I think this will be a great place for grapes and fruit in general. We do not irrigate.

Michael Gorman, San Ardo, Monterey County.—The ten Huasco grape cuttings have grown very well, and are bearing finely.

John Wandell, Hollister, San Benito County.—The Huasco grape has made a fine growth.

Henry F. Speetzen, Watsonville, Santa Cruz County.—Seven of the Chile grapevines are alive and doing well. They are in moist, sandy soil.

Robert G. Adair, Alma, Santa Clara County.—I grafted the Huasco grape upon the Riparia eighteen months ago, and have no fruit this year (1888).

W. T. Reid, Belmont, San Mateo County.—My Huasco vines have two bunches on them. The berries are uneven, but the vines are yet too young to report upon.

Robert Haste, Clayton, Contra Costa County.—The Chile Huasco grape only averages fairly well with the Muscat of Alexandria.

F. Barbour, Clayton, Contra Costa County.—The Huasco grape cuttings which we put out are nearly all growing finely, and I will report to you further when they come into bearing.

L. I. Fish, Martinez, Contra Costa County.—One Huasco grape is living and bears well. It differs but little, if at all, from the Muscat of Alexandria.

George Harvey, Forestville, Sonoma County.—Cuttings of the Huasco grape, planted in 1887, grew ten feet in the season of 1888, and bore some. It seems to me to be identical, or nearly so, with the Muscat of Alexandria.

T. C. Starr, Santa Rosa, Sonoma County.—Nearly all the grape cuttings are growing.

J. H. Adams, Occidental, Sonoma County, writes that nine of twelve cuttings planted February 11, 1889, in red soil, are alive, and have made a medium growth. "I had to take a great deal of trouble, as they were in poor condition when received."

Samuel Turner, St. Helena, Napa County.—Only two out of my dozen Huasco cuttings are alive, and they are making but a poor growth. We had little rain in the spring of 1889, and that little was followed by the drying north winds.

W. A. McKaig, Little Stony, Colusa County.—In my vineyard are Black Hamburgs, Muscats of Alexandria, Rose of Peru, and some unknown vines. The Huasco outyields the others of the same age. It grew about five feet. The grapes were about the size and flavor of Muscats. In general, I may say that grapes do well in this section.

W. H. Brown, Maxwell, Colusa County.—I received a dozen cuttings of the Huasco raisin grape three years ago. I succeeded in growing five of them. They will commence to bear this year (1889). They are making a vigorous growth. I am satisfied they will be well adapted to our hot, dry climate.

Jas. Wheeler, Oroville, Butte County.—The growth of the Huasco grape is about two feet the first season from the cutting.

G. B. Rodgers, Mooretown, Butte County.—Of the dozen Huasco grape scions three have lived, and made good growth. They are perfectly free from all insect pests.

S. P. Hicks, Delta, Shasta County.—None of the Huasco grape cuttings grew. They were lying in the Post Office a week, and became too dry.

C. M. Richards, Cottonwood, Shasta County.—The cuttings planted on hill land of a gravelly nature, unirrigated, made a splendid growth, notwithstanding the very dry summer of 1888. I can see no indication of phylloxera here. I believe the Huasco is one of the very best varieties. It has done better than any other I have, among which are the Flame Tokay, Rose of Peru, Muscat, Black Bishop, and others.

Clara Wood, Sciad, Siskiyou County.—Four of the Huascos rooted, but all save one froze out during the winter of 1887-8. That one was on dry ground, and is doing well. It fruited in 1889 and again last year.

C. Brower, Bakersfield, Kern County.—Huasco grape scions were grafted (1885) into the roots of the Muscat of Alexandria and the Emperor. The former, on a dry, sandy soil, were lost through want of attention and carelessness of my employés; the latter, on low, moist land, and trained upon an arbor, made a vigorous growth from the first, and in 1888, according to my recollection, were about two inches in diameter at the ground. They have borne fruit since 1887. I have been unable to distinguish any difference whatever between the fruit and that of the Muscat of Alexandria on the same arbor. No phylloxera has been reported in this locality, and mildew is not common, except on the Isabella.

F. Duhring, Fresno.—The Huasco cuttings are rooted, and I will report in time if desirable for raisins.

A. J. F. Witthouse, Fresno City.—There are eight out of the twelve Huasco vines growing. They made branches from thirteen to thirty-three inches long and look splendid—as good as the majority of Muscat cuttings I set out at the same time.

G. E. Ladd, Atwater, Merced County.—The Huasco grew thriftily in 1887, and fruited some in 1888.

C. M. West, Elliot, San Joaquin County.—My Huascos were planted a year ago last spring, and fruited this season. I think they will prove valuable here. The growth is more robust than that of the Muscat; the fruit ripened a little earlier, and the musk flavor is more pronounced. Still, they strongly resemble the Muscat. In fact, if planted together, I think it would be very difficult to tell one from the other. Having but few, they were planted in an exceptionally favorable location, which may account for the difference in growth.

G. T. Palmer, Sacramento.—The Huasco grape is doing well. I have raised a few roots from the scions. I grafted the scions into a Zinfandel vine, and they have made a heavy growth. I think it will make a first-class raisin.

F. F. Barss, Placerville, El Dorado County.—The grape cuttings (two dozen) died, except two. They are doing pretty well.

H. A. Messenger, Valley Springs, Calaveras County.—The Chile raisin cuttings have about one half of them grown, but slowly. I think they will come out well next season.

E. W. Maslin, Pino, Placer County.—As to the Huasco cuttings I have nothing to report favorably. I cut the cuttings down to eyes and potted them, transplanted to unirrigated ground, and they have lived, and that is all. My soil is granitic, and four hundred feet above the sea.

Ernest Pillsbury, Auburn, Placer County.—The Huasco grape cuttings made a slow growth, while Muscats planted the same day, in a row adjoining, made a strong growth and fruited the first season. Huasco did not bear until the second season.

James McMenamin, Dobbins, Yuba County.—Ten of the eleven Huasco cuttings received in 1887 grew very vigorously, and they have produced fine grapes this year (1889). They are of a very fine quality and flavor. Grapes of all kinds do well here, ripening from the middle of July until late in November. Phylloxera is not known around here.

Wm. Walker, Olancha, Inyo County.—The grapevines planted in 1889 have done well. I intend to transplant them this fall.

The preceding reports are classified according to location. First come the southern counties; next the Coast Range valleys; next the Sacramento Valley and Siskiyou; then the San Joaquin; lastly the Sierra foothills. The same general order is observed in reports upon other plants, so as to render comparison more easy.

At first view, our correspondents give rather too much apparent emphasis to the likeness between the Muscat and the Huasco. This likeness is most marked on young vines; with age the distinctive features of the Huasco develop. The cluster is shorter, more pointed, and more compact than that of the Muscat. The grape is more free from coulure and sets better in many districts. It is a well known fact that the raisins of this grape, as grown in Chile, bring the highest price paid for any raisins. More extensive vineyard planting can be confidently recommended, especially in districts where the Muscat is an uncertain bearer, as in portions of San Diego and the Sacramento Valley.

It will be observed that especial success is reported from Santa Barbara, San Luis Obispo, Colusa, Shasta, and Yuba. The high flavor of the grapes has been noticed by many of the experimenters. The excellent growth of young vines also attracts attention. Raisin-making should be the next step in every locality on the list.

The Huasco grape has been a subject of much discussion. Its similarity to the Muscat of Alexandria, as noted by most of the preceding observers, was early recognized, and the too hasty conclusion that it was of little value found its way into print. In reality, however, experiments with the Huasco grape confirm the belief that it will bear better in some districts than the Muscat does, and that it may thus serve to extend the raisin districts. If a place is found where, as in Chile, it is more nearly seedless than the Muscat, its value will be much increased.

At Paso Robles station the vineyard contains few more promising early bearers than the Huasco. The present season of 1891 was particularly favorable. The experimental vineyard makes a fine appearance, and the greater part of the vines are carrying fruit. There will be sufficient for tests of many new varieties.

In the Paso Robles district many planters have failed with the Muscat grape. It is said to bear poorly, and its bunches are uneven—entirely useless for raisins. Hon. J. V. Webster tells me that a safe raisin grape could be planted on a large scale in the Estrella region, but that the Muscat will not do. In such cases the Huasco is certainly worth a trial.

THE OLIVE.

Extracts from a large number of letters received from various parts of California illustrate the widespread interest felt in this valuable tree. In a few years more the olive trees at the stations will be large and in bearing. Cuttings and scions can then be distributed on a much larger scale. The nurseries are gradually reducing the cost of budded olive trees, and even now the cost of a few trees is quite within the means of every landowner.

The following reports have been received:

D. B. Hoffman, Helix, San Diego County.—The Nevadillo olive trees are fine, large ones now. They were irrigated four times, from April to November, each year. This part of the State is superbly adapted to the olive, in my opinion, and in time will supply all the oil and fruit that our home market can handle. The two olive trees were two and a half or three feet high two years ago. They are now two and a half and three inches in diameter and six and seven feet high. The growth is very thrifty and hardy, and as clean and beautiful as could reasonably be desired.

Alfred Wright, Pomona, Los Angeles County.—I planted about ten acres of Manzanillo and Nevadillo blanco olives, which have done well, and are beginning to fruit.

T. J. Lanigan, San Ardo, Monterey County.—I set two hundred Picholine olive trees one year old. They put forth new leaves, but did not make any progress. They nearly all died this summer. I noticed that they died after irrigation.

Alex. Manning, San Rafael, Marin County.—I received one Nevadillo and one Manzanillo. Both were of the same size, were planted together, and have received the same treatment. The Manzanillo has made far the larger growth. The extreme cold of the winter of 1888 harmed the Nevadillo. Its leaves first cracked, then turned black, and finally dropped off. The tree stopped growing for a long time, but has now fully recovered. The Manzanillo seemed to grow whilst the other suffered. Its leaves kept green and bright, and it was continually making new wood, until it is now two feet higher than the Nevadillo. Both promise to fruit this year (1891).

Wm. Sale, San Rafael, Marin County.—The olives received in 1888 (Manzanillo and Nevadillo) have made a rapid growth. They are now five feet high, with plenty of strong branches, forming a head three and one half feet in diameter.

G. P. Rixford, San Francisco.—The olive trees (Manzanillo and Nevadillo) sent me in the winter of 1886-7 are both doing well and have made a fine growth. I expect them to fruit some by 1892, possibly this year (1891).

J. A. Benton, M.D., Oakland, Alameda County, wrote in 1889: "The Manzanillo and Nevadillo trees have made a moderate growth. The soil, a cold clay, is not especially good, and the exposure is northwest."

F. Spangenberg, Cupertino, Santa Clara County.—The Nevadillo olive made a vigorous growth of three feet in one year on an unirrigated hillside.

Mrs. E. Burk, Mountain View, Santa Clara County.—The Picholine olives, which were only six or eight inches high when we planted them (February, 1887), now average four feet (September, 1889).

Robert G. Adair, Alma, Santa Clara County.—I have some Mission olives that were planted three years old two years ago, and they are doing well, although without irrigation or care beyond cultivation. More than 50 per cent were sun-scalded, and grew again from below.

W. G. Ellis, Alma, Santa Clara County.—The five Nevadillo olive trees sent me in 1886 I planted in a nursery row until last spring. While there they grew to the height of five feet, though not branched much, but were very healthy and strong, notwithstanding the frosts of 1887 and 1888. In the beginning of February, 1888, I had them moved to permanent places, when three of the five died from the top down. This, I think, was due to the care-

less way they were handled while transplanting. However, I noticed that two of the three grew again from the roots. That the location is adapted to the successful cultivation of the olive I feel sure, as the soil, the climate, and everything else seem to me to be in its favor. I have some hundreds of both Mission and Picholine that have made a wonderful growth, though cultivated but little, and had both heavy frost and very dry, hot weather to contend with.

E. James, Los Gatos, Santa Clara County.—Two olives (Nevadillo and Manzanillo) received two years and a half ago are now doing finely, having grown about two feet last season. They were extremely small, and were, unfortunately, exposed to a remarkable snow-storm when set out. The trunks are now over one inch thick.

L. C. Wittenmeyer, Martinez, Contra Costa County.—The olives (Nevadillo) were planted on upland loam, and occasionally watered. They have continued to make a thrifty growth, not being affected by the cold.

William P. Edwards, Penn's Grove, Sonoma County.—The Manzanillo and Nevadillo olives did very well and were not injured by the cold, though unprotected. Unfortunately, the sheep, through carelessness, got into the orchard, destroyed the Manzanillo and damaged the other, but it revived and is growing rapidly. The hardiness of these olives determined me to devote twenty acres to their cultivation, and I set out two thousand of the Picholine, which are doing very well, barring the loss of some seven hundred from getting heated in coming from the nursery.

G. Hunziker, Cloverdale, Sonoma County.—I report with great pleasure that both olive trees (Manzanillo and Nevadillo) are growing finely without water.

John Smith, Englewood, Humboldt County.—The olive plants which you sent to Mrs. Carr have made about six feet of growth, but are very spindling. They have still to be tied to a support. They stood the winter's cold very well.

J. M. Russell, Anderson, Shasta County.—The olives (Nevadillo and Manzanillo) received in March, 1887, were properly planted, one on gravelly and one on red, rocky hill soil, and mulched with sheep manure. Receiving no irrigation, the growth was very satisfactory, being at least two feet the first season. The extreme cold in January killed the tops of the branches, but by removing the injured parts they started a new and vigorous growth.

Ernest Pillsbury, Auburn, Placer County.—The Nevadillo olives made about three feet of growth the first season, but in January, 1888, were killed to the ground and grew again. One is now about four feet high. A three-year old Picholine olive on the same ground was uninjured.

W. H. Valentine, Lotus, El Dorado County.—The two olive plants made an excellent growth during the season, but were killed by the cold weather of 1887-8. Two trees of the Mission olive, five years old, were not at all affected by the frost, making a fine growth of three and a half feet, and fruiting in 1888.

Mrs. J. D. Enas, Napa.—The Nevadillo olives did very well. I have been advised to plant olives here where it is too rocky to plow, as the rock and soil are favorable to their growth.

C. C. Reynolds, Kelseyville, Lake County.—The Mission olive cuttings all died, or did not make roots.

J. M. Lemon, Valley Springs, Calaveras County.—I planted a small lot of olives on newly cleared chaparral hill land, having a red clayish soil, and having a rotton slate bedrock underneath. The depth of soil was eighteen inches to two feet, and could be pulverized very finely by cultivation. I cultivated well, and mulched the trees in June. I had placed small trees in large holes, and the results of my attention were that 95 per cent of my olive trees lived and are making a thrifty growth without irrigation.

G. T. Palmer, Sacramento.—Of the two Nevadillo olives, one died infected with scale; the other is doing finely. I have put out several cuttings, and layered a few branches.

Isaac Lea, Florin, Sacramento County.—The Nevadillo and Manzanillo are making a splendid growth, but have not fruited yet.

L. D. Greene, Walnut Creek, Contra Costa County.—The olive trees (Manzanillo and Nevadillo) are doing well.

G. E. Ladd, Atwater, Merced County.—The olives (Manzanillo and Nevadillo) grew well from the time of planting in 1887. They grew about two and one half feet by January, 1888, when they were completely killed.

F. Duhring, Fresno.—The olive trees are doing well.

These reports are full of valuable hints. The gentleman from San Ardo, whose trees died, probably irrigated heavily in hot weather. Large trees are liable to suffer or perish under such treatment. With care, as in the case reported from Santa Clara, sun-scalded olives will sprout again from the roots. It looks as if the Manzanillo is hardier than the Nevadillo, from the reports of the cold winter of 1888. The Mission is evidently more hardy than either. Local conditions, however, vary so greatly that no one in the olive districts need hesitate to plant the finer varieties on a small scale, at least. Both the Nevadillo blanco and the Manzanillo succeeded fairly at Anderson, Shasta County; better, in fact, than in some cases reported from counties farther south.

THE CAMPHOR TREE.

Reports from the camphor trees sent out are almost uniformly favorable, and indicate that this tree is already well established in popular esteem. There have been but few failures that can be attributed to frost. The tree thrives on a great variety of soils, and over the larger part of the State. The most serious cause of failure is evidently the blighting north winds, and any extremely hot weather. All who used proper precautions in shading and sheltering until the trees were thoroughly established, have managed to save them.

The station experience can be briefly summed up as follows: At Tulare City the camphor tree has made rapid growth and is an entire success. At Amador it grows well and stands the hot summer sun. At the new station for South California, Pomona, two camphor trees were caught by the north wind in March, and blighted in exactly the way described in several of the following letters. They had just been planted, and the labor of planting out the new orchard prevented them from receiving any attention, or they could have been saved. The camphor will undoubtedly thrive wherever the orange does, but it requires care at first. More trees will be set out at Pomona next spring.

Reports from different parts of the State follow, selected from a much larger number of reports received in answer to letters of inquiry:

John Hudson, Escondido, San Diego County.—The camphor tree looks well.

Abner L. Butterfield, Escondido, San Diego County.—The camphor trees are all dead except one I let Mr. Hudson have. There was a little alkali in my land.

P. S. Russell, San Jacinto, San Diego County.—After protecting the camphor trees from the hot sun, they made a fair growth.

D. M. Dimmick, Carpenteria, Santa Barbara County.—The camphor trees are growing well.

Alfred Wright, Pomona, Los Angeles County.—The camphor trees made a very good growth—two feet. The spring of 1890 was cold and late.

Thos. Spencer, Anaheim, Los Angeles County.—The camphor trees are doing nicely. They seem to thrive with as little care as anything in the garden.

Robert Hansen, Anaheim, Los Angeles County—The camphor trees are growing nicely.

Nathan W. Blanchard, Santa Paula, Ventura County.—The camphor trees, planted last spring, have made very little growth; some have died.

Richard Robinson, Nordhoff, Ventura County.—The camphor tree grew about ten inches the first year after planting.

E. W. Harrold, Saticoy, Ventura County.—The camphor trees grew nicely with little irrigation.

Frederick Allbright, Estrella, San Luis Obispo County.—Three of the five are living. The extreme heat and scantiness of surface moisture were severe on them, though I have watered them repeatedly.

Carroll S. Browne, San Luis Obispo.—The camphor trees (fifteen) received from you last winter all lived and made a good growth. I think they will do well here.

James Dearden, Paso Robles, San Luis Obispo County.—The camphor trees I planted with great care for shade trees, and they seemed to do well for a week or two. We had a late frost that killed them down to the ground. They put out new shoots again, but they finally died.

Frank Dana, Nipomo, San Luis Obispo County.—I planted three camphor trees. One died. The other two have done very nicely, and made about one foot of new growth the following year.

H. M. Maxwell, San Miguel, San Luis Obispo County.—The camphor trees, irrigated and well cared for, seem to be making a good, healthy growth.

E. K. Thoits, Nipomo, San Luis Obispo County.—The four camphor trees are all doing well. They have formed nice tops and look well. They have grown fully one foot, and are very stocky. We think a great deal of them for their beautiful leaves.

Mrs. G. W. Gordon, Salinas City, Monterey County.—All the camphor trees died. I think they got too dry while coming, as they were delayed in the office a number of days.

Isaac Dakin, Laurel Glen Fruit Farm, Santa Cruz County.—Four of the camphor trees died, the bark turning black just above the ground, and the tree slowly turning yellow till dead. The other one is all right and growing slowly.

W. G. Ellis, Alma, Santa Clara County.—Three of the five camphor trees are alive, two of them having made a large growth, one of them a shade under five inches. The third is at a standstill, although receiving the same treatment as the others.

N. E. Beckwith, Los Gatos, Santa Clara County.—The camphor tree seems perfectly hardy, and a rapid grower.

Chas. E. Sanders, Gilroy, Santa Clara County.—Some of the camphor trees died. The best growth was nine and one half inches. They had but little care. The soil is a dark loam and gravel. They were watered about once a week.

Mrs. E. Burk, Mountain View, Santa Clara County.—Of the five camphor trees I gave three to my neighbors, but they did not succeed in getting them to grow. One of those that I reserved I planted on the south side of the house, sheltered from those heavy winds we have, and also gave it a little shade from the burning sun; that one is growing and doing well. The other I planted in front of the house, which has a northwestern exposure; and though protected, it succumbed to a blighting north wind, which scorched the leaves as if they were burnt.

Samuel Swift, Oakland, Alameda County.—The camphor will make a handsome ornamental tree. The plants all lived, and have exhibited much hardiness.

Robert Haste, Clayton, Contra Costa County.—My camphor tree is doing well.

A. B. Harrison, Danville, Contra Costa County.—I am sorry to say that, notwithstanding every attention in the shape of water, cultivation, and shade, my five camphor trees have all succumbed to the extremely hot weather.

F. Barbour, Clayton, Contra Costa County.—We have succeeded in making two of the camphor trees live; they look healthy and are thriving.

T. C. Starr, Santa Rosa, Sonoma County.—The five camphor trees are alive, and have made good growth.

Mrs. V. S. Leber, Santa Rosa, Sonoma County.—A part, only, of the camphor trees are growing. They remained green for several weeks after planting, until a north wind dried the leaves, and they never started again. Those which survive look well. They are not planted in rich soil, and have had water only occasionally. This seems to have been such a long, dry summer (1889) that a great many plants, which usually grow very nicely, have only just managed to live.

E. W. Hayden, Sebastopol, Sonoma County.—The camphor trees are doing well. They have made a growth of about eight or ten inches without any irrigation, and they are looking fresh and healthy. The camphor tree is a beautiful thing. I had one at Novato, Marin County, that at four years of age was eight feet high, and spread out in proportion. It is very desirable. The foliage is always bright and clean and never troubled with insects.

Leslie Hoag, Boonville, Mendocino County.—Three trees with light-colored foliage lived and grew. They seem quite hardy, and stood the frosts well. Two trees with dark-colored foliage were very tender, and the next spring's frost killed them.

S. P. Hicks, Delta, Shasta County.—Two of the camphor trees are growing nicely now. Three were killed down by the sun, but have sprouted from the roots, and are now six inches high. I think the sun would have killed all had I not shaded them with shakes.

J. H. Jansen, Redding, Shasta County.—The camphor trees all died, save one which sprouted from the root. They all did well at first, but were all caught, one after another, by a kind of black blight at the top of the ground and descending to the root.

F. G. Taylor, Ophir, Placer County.—The camphor trees are one half of an inch thick (trunk) and over four feet high, and look fresh and hardy. The soil is not extra good.

H. B. Gaylord, near Auburn, Placer County.—The camphor trees have done remarkably well.

Geo. W. Bonds, Newcastle, Placer County.—My trees remained at the railroad station until they were dried out badly. Only two started out of the lot. I buried them in the ground for a week before setting them out. They have made a fine growth.

Mrs. N. C. Alley, Roseville, Placer County.—The camphor trees all died. The north wind which sweeps through here killed them. I have lost many other much more hardy shrubs this way.

T. Kindlespire, Proberta, Tehama County.—Out of four camphor trees, I have but one living.

Joseph Clark, Anthony House, Nevada County.—Of the five camphor trees, we found one dead on arrival, and one has died since; the rest are doing well to all appearances, having made a growth of six inches.

George Thompson, West Butte, Sutter County.—I planted the five camphor trees in sandy, gravelly soil without water. They grew finely and looked well till the last of July, 1889, when they died. If I had irrigated, they would have lived. They had no insects whatever.

Jas. Wheeler, Oroville, Butte County.—The camphor tree will grow here as well as the orange. Its growth for the season is about eight inches.

J. H. Rafferty, Wyandotte, Butte County.—The camphor trees grew until the warm weather came, then they all died. Some had borers in the roots, but some did not. They all died from the top down.

J. W. Mills, Marysville, Yuba County.—I could not make the camphor trees grow.

Wm. H. Pyle, Elk Creek, Colusa County.—The trees stood the winter splendidly, but the hot weather through July and August killed all of them. The sun would kill each new growth as fast as it appeared. I am quite well satisfied that the camphor trees will not do in this climate.

Henry Montoux, Williams, Colusa County.—The camphor tree is a hardy and rapid grower here.

Nicholas Flanagan, thirteen miles northwest of Orland, Colusa County.—Of the five camphor trees received, but three are growing. The wet weather which prevailed when they were

received, made us unable to plant them until late in the season. Then dry weather set in almost immediately.

Wm. Walker, Olancha, Inyo County.—The five camphor trees grew finely until about August 20th, when they began to decay about two inches from the root, and I cut them off. They have not sprouted again.

F. M. Gaffney, Middletown, Lake County.—I received five camphor trees. Four of them have made no growth at all, although they are alive and look healthy. The fifth has grown three inches. They have had no irrigation, but I have cultivated them three times. The coldest weather since trees have been planted was 25 degrees Fahrenheit.

Richard Wylie, Napa, Napa County.—The camphor tree stood the hard winter of 1887-88 and that of 1890 without the least injury, and is growing luxuriantly.

H. W. Turner, Valley Springs, Calaveras County.—The camphor trees, planted in red foothill soil and irrigated, are growing slowly.

H. A. Messenger, Valley Springs, Calaveras County.—The camphor trees have grown finely, and appear to be at home in this soil and climate.

G. E. Ladd, Stockton, San Joaquin County.—The camphor trees, planted in black adobe, are growing rapidly.

A. J. F. Witthouse, Fresno City.—The camphor trees made a few leaves at first, but by the beginning of April a black spot appeared on the stem of the trees about two inches above the ground. In a few days the spot made a black ring one inch or more around the tree. The top remained green about two weeks, and then died. The roots sent up small sprouts about two inches high, and then died. One and two-year old walnuts were killed in the same way. The soil is heavy, with considerable alkali.

W. F. Stewart, Tulare City.—Of five camphor trees four died. I believe they had too much water.

The reports cover almost the whole State. The necessity for a full knowledge of local conditions is shown by the report from Paso Robles, where frost killed the trees. This is on low land near the river; on the bluffs the camphor does well. In places like Fresno, the sun-scald is bad; trees ought to be sheltered for a few years. The bark of the camphor is sensitive to the extremes of temperature; a low head should be formed by pruning, or it should be planted in shrubbery or orchard, already established, in places where its hardiness is a matter of doubt.

THE CAROB.

No tree distributed by the stations is more likely to make a popular shade and ornamental tree for dry, rocky situations than is the true carob of Southern Europe and Asia Minor. Aside from the fruit, whose well attested economic value ought to induce more planting, the tree is of striking and attractive appearance. In rich valley soils it does not bear early, nor yield so abundantly, as in its own home, the warm, rocky hill country. Its culture, however, will not become general until after that of the olive and the fig, which offer better returns.

The most instructive of the following reports is one from San Diego County; no cultivation, no water, and planted on *mesa* land—but the trees did better than any others so far as heard from:

B. J. Rice, Fallbrook, San Diego County.—The carob trees are all alive and seem to be entirely hardy here. The largest one is eight or ten feet high. They are on high land, and have had no water or cultivation.

Wm. Chappelow, Duarte, Los Angeles County.—Five years ago I received samples of carob trees, which stood the first and second winters, but were killed by the heavy freeze of 1888.

D. H. Temple, Los Gatos, Santa Clara County.—The carob trees grow slowly, but are not affected by the frosts.

G. P. Rixford, San Francisco.—The carob trees are doing well, but I find require some protection from frosts while young.

Francis G. Smith, Healdsburg, Sonoma County.—In the spring of 1886 I received five carob trees. They did well and made a growth of about two feet, but the cold weather of 1888 killed them, root and branch.

Thomas Mahoney, Marysville, Yuba County.—My carob trees that were growing nicely were killed by the frost.

Isaac Lea, Florin, Sacramento County.—The carob trees are growing, but slowly, although I water them.

Miss C. M. Vincent, Lockeford, San Joaquin County.—Though the tops of the carobs were killed by frost, the trees sprouted from the roots and are doing fairly.

THE CORK OAK.

It is worth while to push the culture of the cork oak of Spain, particularly in the Sierra foothills. The larger part of the State is eminently adapted to oak plantations, as the success of the English oak shows; but while that is better adapted to the coast region, the cork oak will probably grow faster in warmer districts. But the cork oak is very hard to transplant. Even the English oak does best when removed at only one year. An acorn planted where it is to remain, will often outgrow the transplanted yearling. The cork oak is even better adapted to seedling plantations. Once fairly rooted, the cork oak will grow more rapidly each successive year.

Abner L. Butterfield, Escondido, San Diego County.—The cork oak trees are all dead. There was a little alkali in the ground.

P. S. Russell, San Jacinto, San Diego County.—The cork oak began to grow in the spring, but as the hot weather approached they all died.

William Chappelow, Duarte, Los Angeles County.—My cork oaks planted in sandy soil look very thrifty and nice, and made a growth of nine inches the first year.

Alfred Wright, Pomona, Los Angeles County.—The cork oaks died. The spring was cold and late.

Robert Hansen, Anaheim, Los Angeles County.—The cork oaks are growing nicely.

D. M. Dimmick, Carpenteria, Santa Barbara County.—The cork oaks are growing well.

Mrs. M. E. Lyman, Santa Ynez, Santa Barbara County.—The one cork oak is doing well.

Nathan W. Blanchard, Santa Paula, Ventura County.—The cork oaks were carefully planted, but made very little growth.

Richard Robinson, Nordhoff, Ventura County.—The cork oaks made a growth of twelve inches the first season.

Carroll S. Browne, San Luis Obispo.—One cork oak is alive, but has made a very slow growth.

H. M. Maxwell, San Miguel, San Luis Obispo County.—The cork oak trees are making a slow but normal growth, about the same as wild native oaks of the same size and age on the hills.

F. Barbour, Clayton, Contra Costa County.—The cork oaks did not thrive. I think the dry season is too much for them. We do not irrigate.

A. B. Harrison, Danville, Contra Costa County.—Two of the four cork oaks have survived, but are looking very weak. I am strongly of the opinion that had the oaks been stouter plants, they would have succeeded in fighting their way through a very untoward and trying season.

J. M. Stitt, M.D., Vacaville, Solano County.—The corks have all grown well.

John Marshall, Sebastopol, Sonoma County.—The oak trees received in 1889 are still alive and growing slowly.

F. Closs, Auburn, Placer County.—The cork oak made a growth of nine inches, and looks perfectly well. In Forest Hill, Placer County (altitude two thousand five hundred feet), is a tree raised from seed, planted about 1855, and it is now about forty feet high.

H. B. Gaylord, near Auburn, Placer County.—The cork oaks have done remarkably well.

J. W. DeLamater, Newcastle, Placer County.—Two of the cork oaks are living and doing well. They made only about one inch growth.

F. G. Taylor, Ophir, Placer County.—The cork oak trees are fine and rapid growers, one having sent out a limb twenty-two inches long.

R. S. Alderman, Smartsville, Yuba County.—Two of the small cork oaks I planted near the irrigation ditch, but they failed to respond. The other two, planted in the potato patch, started nicely after a time, but the most promising one gave out; the other lives, but is scrubby.

Nicholas Flanagan, thirteen miles northwest of Orland, Colusa County.—One of the cork oaks is growing. It has made a growth of about six inches. The others died from a too long delay in setting out.

Samuel Turner, St. Helena, Napa County.—Three of the four cork oaks started to grow. One of the three died in a hot spell; the other two are looking well. I keep hoeing around them to keep the soil loose.

Isaac Lea, Florin, Sacramento County.—The cork oak and nut-bearing trees are doing well.

G. E. Ladd, Stockton, San Joaquin County.—The cork oaks, planted in black adobe, are doing poorly.

A. J. F. Witthouse, Fresno City.—One of the cork oaks kept alive until the middle of May, then died all at once; the others did not start.

Thomas Jacob, Visalia, Tulare County.—There is a large cork oak tree in this town, but I have never seen any acorns on it.

Light soils are best adapted to the cork oak, and it will not thrive on shallow or heavy adobe soils. Granitic soils seem to suit it specially.

It should do well in the San Joaquin River region, where such soils prevail, as well as in the foothills. It is naturally of slow growth.

BAMBOOS.

Reports from the bamboos sent out by the University come in slowly, but cover a good deal of territory.

A plant of *Thamnocalamus*, sent to *W. Haddox, El Monte, Los Angeles County*, grew the first year, but died the next from "alkali in the soil." The land was very moist "corn land." Ramie grew upon it with extraordinary vigor.

D. M. Dimmick, Carpenteria, Santa Barbara County, reports: The *Metake* bamboo seems to be the same variety that I have growing under another name, and which does not yet get large enough to make even fish poles. A plant that my neighbor got from Sanders for the "giant bamboo," but which is the same as that grown by other neighbors as "southern cane," seems to be of value, making canes nearly two inches in diameter by twelve to fifteen feet high.

Mr. L. Guss, of Wright's Station, states that the canes of his plant are now nine feet high, on very dry land; no irrigation. The variety is the *Thamnocalamus spathiflorus*. It was not affected by the winter, nor did it blight in the summer heats.

F. Spangenberg, of Cupertino, Santa Clara County, writes: "The *Metake* bamboo was received in February, and put out the first year four shoots four feet long and one fourth of an inch in diameter. The second year, 1888, it sent up four shoots six feet and three eighths of an inch in diameter. It is now an immense clump or group of stems. The *Ringal* bamboo, received in 1888, appears more vigorous than the *Metake*. The soil is a good sediment, but not irrigated.

Mr. R. Butcher, of Santa Clara, planted the *Metake* bamboo, and the canes are ten or twelve feet high, vigorous and healthy. It received the same irrigation that the roses and shrubs did. It "spread underground" so fast "as to become a nuisance." He uses the canes for supports for small plants. Otherwise the value of the bamboo appears to him "purely ornamental."

The most complete report received was written by *George E. Colby, of Claremont, Alameda County;* the variety is the *Arundinaria falcata*. He says: "The height attained this season, 1890, is fourteen to eighteen feet; the diameter of the cane is about one half to three fourths of an inch at the base. The plant was watered two or three times a week till last year; then irrigation lessened one half. It is planted in the lawn; soil for space of two feet around plant kept well and is deeply tilled. During the winter of 1887-8, the coldest for many years here, the plant did not appear to suffer in the least; during September, 1889, the 'norther' struck it with full blast, and, aside from whipping off some of the leaves, it was not injured at all. When planted (1886), the canes were about ten in number, of the size of a lead pencil in diameter, and about three and a half to four feet long. At the end of the first season it stood eight to ten feet high, with a solid clump of canes about eighteen inches in diameter. At that time the plant was divided, leaving about one half standing; since then it has grown to its present height, and is over two and a half feet in diameter. The total number of canes grown by this plant since 1886 is one hundred and seventy-five. As an ornamental plant for lawns it certainly can hardly be equaled, and it attracts a great deal of attention."

Full reports of the *Ringal* and *Metake* species come from Robert Haste, of Clayton, Contra Costa County; from E. D. Wheatley, of Delano (whose plants died; alkali soil); from A. Keith, of Riverside; H. B. Gaylord, of Auburn; A. B. Harrison, of Danville; and E. W. Harrold, of Saticoy. These kinds seem to have done better, as a rule, than the Indian species, the *Thamnocalamus*.

Arundinaria falcata, sent to George Harvey, of Forestville, grew eight feet high the third year, with canes one inch in diameter. It was perfectly hardy. Another variety showed canes fourteen feet high "on shallow soil." He uses this bamboo to some extent for fencing. He makes the suggestion that bamboos planted along watercourses would be much better than willows—more free from insects, and far more useful when established.

Mr. Charles Knust, of Cloverdale, reports failure through cold and drought, he thinks. "The soil," he says, "is too dry and gravelly." Guavas sent to him are thriving.

Mr. W. Still, of Sonoma, tested the *Thamnocalamus*, and he also reports failure, both with plants from the University and with an importation from Honolulu. He advises larger plants sent out later in the season, after frosts.

W. H. Reed, Chico, Butte County, says: "I think there is no question as to the bamboo's adaptability to this climate, as each lot has done finely. They took root at once and sent out quite a number of shoots from two to four feet high during the summer. All it needs here is plenty of water. I have three other varieties, all doing finely.

THE MULBERRY.

It is likely that some of the best species and varieties of the mulberry as grown in this State, many of them introduced by the University, will become leading avenue trees. The value of the mulberry for shade, for fruit for home use, for timber, ultimately for silkworm culture, and its extreme ease of culture, make it desirable that people should know more about the tree. It thrives on widely different kinds of soil, and at all the stations. The trees on the University grounds are very attractive specimens; plants and cuttings have been sent to all parts of the State.

The following memoranda from various growers will serve to illustrate the widespread success of the tree:

Frederick Allbright, of Estrella, San Luis Obispo County.—I have saved three out of the dozen cuttings sent me, and the trees are from ten inches to one and a half feet high, looking finely. I irrigated once every week or two, by removing the surface, watering plentifully, and then replacing the earth. Some Russian mulberry trees (received from Kansas) started quite slowly, and the heat and dryness were pretty hard on them for a time; but at length they started and are growing through the hottest weather, as though California *adobe* were their native soil. I take it, that the Russian mulberry will be very valuable to set out for posts for our wire fences; the *Nagasaki* is the best.

George Weiss, Creston, San Luis Obispo County.—The cuttings (Russian, Alba, and Nagasaki) failed to take root, though I watered them frequently. The Russian mulberries sent me before, start to grow too early and are caught by the late frosts. The New American mulberry is much better. It has made a growth of eleven feet in two years from the bud, and has borne fruit for me since 1888.

R. Ship, Arroyo Grande, San Luis Obispo County.—In the spring of 1887 I received from the University six varieties of mulberry cuttings. Several failed to start; some started and soon died. The gophers ate most of the rest; only one is living now. This one got badly frosted in January, 1888, the ends of the branches being wilted, and a gopher ate nearly all the roots off. I replanted it, and it is making a fair growth. A neighbor has one mulberry tree which has grown well and is beautiful.

H. M. Maxwell, San Miguel, San Luis Obispo County.—Four varieties of mulberry (Downing, Russian, Alba, and Nagasaki) made a fine, bright, and vigorous growth from cuttings planted in sandy loam and transplanted January, 1888. They are now, in 1890, large trees.

T. J. Lanigan, San Ardo, Monterey County.—The mulberry cuttings budded and formed branches, but afterwards perished with the dry summer season.

A. P. Roache, Watsonville, Santa Cruz County.—The mulberry cuttings failed to strike root. They budded, leaved, and the young shoots attained four or five inches in length, when suddenly they began to wilt, and they died in spite of my efforts.

Robert G. Adair, Alma, Santa Clara County.—The Japanese mulberries are doing splendidly; 50 per cent of the cuttings grew.

C. C. Reynolds, Kelseyville, Lake County.—The Downing mulberry cuttings were budded into White mulberry stocks, and have made a heavy growth. The New American on the White, by buds, has done exceedingly well. Buds put in last spring are seven feet high. None have fruited yet, but this is evidently the home of the mulberry.

Of the many species of the mulberry, *Morus alba, M. nigra, M. multicaulis, M. rubra, and M. japonica*, with their sub-varieties, are best adapted to the greater part of the State, including the interior, where they rival the fig in enduring heat, even where only a moderate supply of moisture is to be had. At the station in Amador, and that at Paso Robles, they have grown better than any other tree. The hot weather of the last two summers affected their foliage but slightly. The best growers, and the handsomest trees of the group, have proved to be the Japanese *Nagasaki* and *Lhoo*, which also have a large leaf of close texture, admirably adapted for the food of the silkworm. First, let mulberries be planted along our roadsides until the tree is as common

and familiar a sight as the willow. Then, with more abundant labor and the development of the Old World industries, silk culture will take its place among the profitable occupations of California.

The Japanese varieties just named undoubtedly take the highest rank of all the known sorts for general planting in California. In three or four years a farmer can get shade and shelter about his house and outbuildings by using these large-leaved and fast-growing mulberries. The White has much smaller leaves and gives much less shelter.

NEW ZEALAND FLAX.

The astonishing strength of the raw fiber of the New Zealand flax (*Phormium tenax*) makes the plants valuable for every gardener and farmer, who can use strips of the leaves for many purposes. A distribution of this plant was made several years ago, and sufficient time has elapsed to bring in some reports, from which the following notes are selected as typical of all:

Mrs. L. S. Cleland, Mesa Grande, San Diego County.—Not knowing its nature or habits, I planted the New Zealand flax seed in a very sunny exposure, and the young plants were burned off in a single hot day.

P. S. Russell, San Jacinto, San Diego County.—The New Zealand flax started to grow in the spring, but as the hot weather approached it all died.

John Wandall, Hollister, San Benito County.—The New Zealand flax is doing well.

S. Slocombe, Cayucos, San Luis Obispo County.—The *Phormium tenax* died; the soil and climate, I believe, are too dry for it.

Wm. Quentel, Pacific Grove, Monterey County.—The New Zealand flax grows well, and is both ornamental and useful.

G. Rothermal, San José, Santa Clara County.—The cold of January (1888) did not hurt New Zealand flax. Its growth is luxuriant.

F. Spangenberg, Cupertino, Santa Clara County.—Although my New Zealand flax is not as thrifty as reported from Santa Cruz, still it is vigorous and useful enough to pay for all the attention given it. It grew three feet in moist sediment, although removed and replanted under unfavorable circumstances.

G. P. Rixford, San Francisco.—The New Zealand flax seems to prove successful everywhere except in very dry locations, where it will require some irrigation. We find it exceedingly valuable on the ranch (in Sonoma County) for tieing purposes; the fiber is so strong that it is useful for tieing up vines, trees, sacks, or any other purpose for which tieing material is used.

Alex. Manning, San Rafael, Marin County.—The New Zealand flax was doing nicely until a neighbor's cow entered and tore it from the ground.

Wm. H. Hilton, Glen Ellen, Sonoma County.—The New Zealand flax continues to do well. Last winter we had unusually cold, frosty weather, but it did not affect the plants. They are set in clayey loam, and require watering.

A. Requa, Cahto, Mendocino County.—The New Zealand flax grows well in my flower beds.

James Hodge, Hanson, Humboldt County.—The New Zealand flax makes a rapid growth, and has very strong fibers. It is very handy for tieing purposes.

E. W. Maslin, Pino, Placer County.—I have planted the New Zealand flax twice. It seems to flourish so long as the spring is cool, but upon the first heats of summer it gradually dies down to the bulb, which, upon examining, I found dead. This is on unirrigated granitic soil.

Isaac Lea, Florin, Sacramento County.—The New Zealand flax will not grow here without irrigation.

C. Brower, Bakersfield, Kern County.—One of the New Zealand flax plants was planted in moist bottom land; others in sandy loam slightly more elevated. Those on the sandy land, though moderately irrigated, failed to survive the summer (1886); that on the low land appeared to suffer from the dry heat of summer, and it has never made a vigorous growth, though still living and slowly increasing in size and apparent health. It is now about three feet high, and some twelve inches in diameter at the ground; is apparently not adapted to the dry heat of our interior valleys, and in point of ornament is far inferior to the pampas grass.

The New Zealand flax, as shown by the above reports, is not adapted to many locations removed from the seacoast. It does not thrive in too hot districts, nor on the driest soils. But it needs drainage; the roots must not reach bottom-water. Moderately moist soils suit the

plant best. It is not a swamp plant, as many seem to think, but does best in good garden soil, well cultivated.

THE MELON TREE.

The true place of the melon tree (*Carica papaya*) is pretty well established in California horticulture. It is only a few climates, such as that of Montecito, Santa Barbara County, and southward, that have the slightest chance of success with this tender plant. Report has been made before now of the thriftiness of the *Carica papaya* in San Diego County. Some Los Angeles, Ventura, and San Bernardino locations, and some limited areas of the Sierra foothills, might possibly come up to the very satisfactory report from Montecito.

N. E. Beckwith, Los Gatos, Santa Clara County.—The melon tree, I think, is worthless here. In the hot summer weather the flowers blast or drop off, and the fruit only sets in the fall in cool weather, and then does not get ripe before rain and cold spoils the plant. I am in doubt if the fruit is of any value when you do get it, though the plant is quite ornamental.

Wm. Chappelow, Duarte, Los Angeles County.—Two melon trees were sent, but both have died, from what cause, I know not. They were planted in sandy soil.

D. M. Dimmick, Carpenteria, Santa Barbara County.—The melon trees did not get frosted, but seemed to chill, and then died.

Kinton Stevens, Montecito, Santa Barbara County.—The two melon trees have made a fine growth. I think so much of them that I procured seed from China, and have about three hundred fine plants. I feel sure, that with a little care while young, it will succeed as well with us in Montecito as the *Anona cherimoya*, the alligator pear, and the mango, which do well, producing and perfecting their fruit.

Henry F. Speetzen, Watsonville, Santa Cruz County.—The melon trees never showed any sign of life after I planted them in the open air on a sheltered spot.

C. H. Sheldon, San Buenaventura, Ventura County.—The melon trees died. I have a very favorable location, and I think they were killed by the cold in coming, for they commenced to decay at the top of the ground almost immediately; it did not seem to be a dry rot, but they turned black, and became slippery.

Frank Dana, Nipomo, San Luis Obispo County.—The melon trees were killed by a gopher. The smell of the tree seemed to attract the gophers, as both trees were killed by the same rodent, although they were twenty feet apart.

Robert Hansen, Anaheim, Los Angeles County.—A stray cow destroyed the melon trees.

A. Keith, Riverside, San Bernardino County.—The melon trees both died. The cause was a rainstorm soon after setting them out. I think they must be extremely tender.

William Pfeffer, Gubserville, Santa Clara County.—Owing to ignorance on my part about treating such plants as melon trees, I found them, four days after planting, dried up (on a warm hillside).

Thomas Spencer, Anaheim, Los Angeles County.—I regret to state that the melon trees succumbed to the extraordinary weather of January 16th, when the thermometer registered 26 degrees. I nursed them carefully, but they soon began to rot, and then died.

OTHER DISTRIBUTIONS.

Guavas.—Several reports have been received about the guavas sent out in 1884. C. O. Tucker, of Ballena, San Diego County, writes that from his experience he "has formed a very high estimate of the value of the tree for this locality."

Coffee.—It is often said, by those who have not taken pains to ascertain the facts, that large coffee plantations will certainly be seen in California some of these days. The place for a commercial success in this culture has not yet been discovered. Witness the following: Mr. A. Keith, Riverside, writes as follows: "Six coffee plants were received from the University about 1884. I took a great deal of pains with them, but the last one died in 1888. I do not believe that they can be made to grow out of doors in this climate." Mr. B. J. Rice, Fallbrook, San Diego County, reports a similar experience.

The *Catalpa* was sent out to all parts of the State, and did very well,

particularly in San Luis Obispo, Santa Clara, Alameda, and Sonoma Counties. M. C. Woodson, of Nuevo, San Diego County, writes: "I have one thousand *Catalpa speciosa* on high, dry mesa land that have made a growth of from four to seven feet this year. I think the catalpa is the most desirable and most profitable timber to grow.

The *Strawberry Tree* (*Arbutus unedo*) appears to have done fairly well in most counties of the State. Reports show that it has lived and grown, though slowly, in San Luis Obispo, Calaveras, Mendocino, Los Angeles, Santa Clara, Humboldt, Monterey, Sonoma, Colusa, and Tehama Counties. It does better near the coast; the hot, dry climate of the interior valleys appears to check its growth. At Fresno, where the thermometer registered 114 degrees Fahrenheit the season reported, the tree did very poorly. Nevertheless, a tree in Inyo, where the heat was probably greater, appears to have succeeded. The tree responds quickly to irrigation.

Of the various *Maples* that are native of the country east of the Sierras, none except the *Acer negundo*, or "box elder," has ever equaled our native California species. The most valuable of the native species is the *Acer macrophylla*, which, in suitable soil and within the range of the moist ocean winds, is of enduring and rapid growth. It can be highly recommended as an avenue and shade tree. The timber, also, is quite valuable.

PLANTS ALONG NORTH STRAWBERRY CREEK.

By Charles H. Shinn.

No portion of the University grounds is more interesting to a botanist than the narrow, winding border planted with shrubs, vines, and trees, and extending along the north bank of North Strawberry Creek. This border begins near the greenhouses and continues west, with a few breaks, past the nurseries, the seedhouse, orchard, and new grape plantation, and across the Economic Garden. The most attractive portion is in this latter division, extending west to the boundary of the University grounds.

Native shrubs and trees, left standing when the ground was broken for the garden, mingle with the exotics. Close by the greenhouses the cutting of trees that overshadowed the beds has given some interesting plants a better chance for growth; one of these, *Brugmansia sanguinea*, is one of the most attractive semi-tropic shrubs for ornamental planting. Its funnel-shaped flowers of yellow and pale scarlet are eight or nine inches long and three inches across. As if to mark with special emphasis the climatic contrasts, a fine *Sequoia sempervirens* (redwood) and a deciduous cypress of the South stand near this semi-tropic datura.

Passing between two large live oaks, beneath whose shade several Japanese camellias are growing vigorously, the cordon walk of pear, apple, and cherry is the next feature, but this has been amply described in previous reports. The pears and apples have almost no crop this year; the cherries (Governor Wood) bore a fair crop.

West of the cordon walk several good specimens of English oaks stand near the bank. Adjacent to them is an oak nursery, in which five or six species stand, with a few specimens of the *Chionanthus Virginica*, or Fringe tree. The wild-plant garden extends north from here.

Crossing a path the mulberry plantation is reached. *M. multicaulis*, *M. alba*, Downing's ever-bearing, the Russian, the Japanese, and the Chinese are represented here; the Japan species (Nagasaki and Lhoo) are the strongest growers, while the Russian seems comparatively poor. Several healthy specimens of the Japanese mammoth chestnut are here; they have a remarkably low and spreading habit, in this soil, at least, a habit quite unlike that of any other chestnuts, and different from that of the same species in some other localities. A tree of the European *Diospyros*, or persimmon (*D. lotus*), on the bank of the stream, is beginning to bear fruit.

Passing the seed-house, built across the channel of the creek, the orchard comes close to the bank, and there is only room for a few things, chief among which are mountain ashes (*Sorbus Aucuparia* and *S. Americana*), and several of the best species of *Cratægus*. All of these are particularly ornamental in winter. A specimen of hickory (*Carya alba*) is at last beginning to make a fair growth. A large tree of the *Hovenia dulcis*, a highly recommended fruit-bearing tree from Japan, has proved a disappointment so far, not yet showing any signs of blossoming. There are specimen trees of wild crabs along the creek here, and places where plums and other native American fruits can be planted. The western apex of the triangle, between the bend of the creek at this point and the roadway, is marked by an olive tree, and south of the creek by the beginning of the eucalyptus grove. This grove once extended north of the creek, but in the autumn of 1890 a portion of the land was cleared, and a collection of different species of grapes was planted last spring. The space occupied is properly a part of the extended creek border.

The creek border in the Economic Garden covers a much greater variety of plant-life than any other part of the strip of territory under consideration. A few rods of the narrow border here would interest any botanist. A finer illustration of what California gardeners can easily do with the broken slopes of ravines could hardly be found. Live oaks, buckeyes, and laurels grow on the banks, and vines of wild pea and blackberry clamber over them. The pomegranates, oranges, bamboos, and plants to be hereafter noted, have become established in the midst of such native specimens.

One of the finest trees here is a large camphor, which thrives wonderfully. A *Salisburia adiantifolia* is close to the camphor; also, a large specimen of *Rhus Coriaria*, the true tanner's sumac. Thorny *Acacia Greggi*, and other Arizonian plants of the desert, grow, though not rapidly, and the *Agave Americana* is perfectly at home. A carob tree (*Ceratonia siliqua*) stands fully twelve feet high, and quite that much in width. The useful and interesting honey mesquite of the Southwest (*Prosopis juliflora*) is represented by a healthy, though small, plant. A superb specimen of *Ruitzia fragrans*, a Chilean tree, and several other very handsome Chilean species, are worthy of especial notice. *Pistacia terebinthus* and *P. vera* grow near each other, sheltered by native oaks. A plant of the thorny *Aberia Caffra*, or "kai apple" of South Africa, seems to thrive, though increasing in size but slowly; this plant suffers from the slightest frost, and is less hardy than the lemon.

Close to the bank of the stream, but separated by a narrow path lined by violets, is a large vine of the curious *Pueraria Japonica* supported upon a trellis. This is the "starch" vine of Japan, and its handsome flowers and rapid growth make it worthy of ornamental use, while its

large tubers are said to be valuable for food. Other plants of the immense leguminous class are to be seen in the vicinity—the superb *Edwardsias, E. grandiflora* and *E. microphylla;* the *Virgilia lutea, Cercis occidentalis*, several species of *Cytisus*, and a wall of acacias, twenty-three species of which are grown in the experiment grounds. A charming little tree of graceful foliage is the *Sophora Japonica*, extensively cultivated as a dye-wood.

The narrow border shows several of the *Araliaceæ*, such as *A. spinosa*, the Hercules club; the odd "rice-paper" tree, *Fatsia papyrifera;* and a number of ivies. There are wild gooseberries and currants, *Ribes sanguineum* and *R. Menziesii* being most important, both of these native species left growing with blackberries, honeysuckles, oaks, and willows.

Among the rarer plants now of considerable size, and showing adaptation to the locality, are two *Cinnamonums, C. glaucum* and *C. sericum;* the slow-growing *Macadamia ternata*, or Queensland nut-tree; the stiff-leaved, brilliant-flowered *Hakea acicularis*; the "tallow-tree," *Stillingia sebifera;* and the *Cinchona officinalis*, which sometimes needs a little winter protection. *Psidium Cattleyanum*, the purple or strawberry guava, forms a large bush, untouched as yet by frost. *Thea bohea*, the Chinese tea plant, grows fairly well. The Argan tree of Barbary (*Argania sideroxylon*), the stiff-leaved *Berberis Japonica*, with greenish-red berries, and the purple-leaved hazel, grow near the guava, tea, camphor, and cinchona plants.

A few hundred feet from the stream many other plants of interest are found, and the range of species is greatly increased. But it was stated at the outset that this was to be merely a glimpse of the part of the experiment grounds that lies along the brook, from the greenhouses west to the University boundary. Many of the species represented here have not been mentioned, but the range of climate is perhaps sufficiently indicated.

THE WEEDS OF CALIFORNIA.*

By E. W. Hilgard.

It has ceased to be usual to begin a history with the account of the creation; and even thus, it might be unnecessary to begin a treatise on weeds with a definition of the meaning of the word, were it not that common usage attaches to it two really distinct ideas, having in common only that of a hardy plant that is of no particular use. But to one class attaches the reproach of being a persistent invader of the husbandman's realm, difficult to repel; while another consists simply of hardy plants, thriving under difficulties which discourage more useful growths, and therefore obtruding their presence on roadsides and other waste places. It will hardly do to go so far as to attach the opprobrious term to *any* plant that habitually appears in a place where it is not wanted, despite the analogy of the "dirt" on the goldsmith's apron, and the "pay dirt" of the placer miner.

It has not uncommonly been noted, as a matter of surprise, that the troublesome weeds of any country are rarely aborigines thereof. In reality this is probably but one of the phases of the survival of the fittest

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under *natural* conditions, for neither roadsides and waste places on the one hand, nor cultivated ground on the other, can be placed in the latter category. In order to become a weed, a plant must be placed under *unnaturally* favorable conditions, unlike those which have naturally concurred toward the secular co-adaptation of plants, soils, and climates. We see the converse process in the complete disappearance of native plants that have formed the predominant growth, as, *e. g.*, that of the buffalo grass (*Buchlöe*) from the plains of Nebraska and Colorado, not as the result of displacement, but of unsuitable conditions; while the thistle on the pampas, and the guava on the Hawaiian group, are examples of almost complete displacement of native growth by foreign invaders.

In California the progress of the invasion by some of the most common weeds can be currently traced as yet in the more remote regions, and the influence of climate in modifying the "weed nature" of a number of well known plants forms an interesting study.

The broad fact in the premises that first strikes the newcomer in California is that a number of plants that are the subjects of careful culture east of the Rocky Mountains, as well as in Europe, and which quickly succumb when deprived of artificial protection there, are here found among the most persistent and obnoxious weeds; while very many of those that are specially abundant and troublesome in the Atlantic region, are conspicuously absent on the Pacific side. Foremost among the former class are the two "mustards," *Brassica rapa* and *nigra*, respectively known as "white mustard" (or "wild turnip") and "black mustard;" and next to these, the common radish (*Raphanus sativus*—not *R. raphanistrum*, of the European fields). The first named is most abundant on the borders of the bay of San Francisco, and occupies not only abandoned fields, but disputes the ground with the cereals to such an extent that it is often difficult to believe that it has not been planted on purpose; and were rape-seed oil as much sought after as of yore, California could doubtless "beat the world" in growing its parent plant.

The black mustard is of more extended prevalence, and both in the coast region and in the Great Valley takes possession of neglected fields to the exclusion of everything else, growing so tall in rich soils as to hide horse and rider, and forming impenetrable thickets that, like the thistle of the pampas, serve as a place of refuge for wild animals. In the Santa Barbara region such mustard patches are often cut for their seed, which is extremely pungent; but the crop often fails, in consequence of the overwhelming attacks of an aphidian upon the peduncles and forming pods. Apart from this latter drawback, California could also probably defy competition in mustard culture.

The radish is not quite so overwhelming in its attacks upon cultivated ground, but large patches of its rose-colored flowers often contrast very prettily with the prevailing yellow of the two *Brassicas;* and the extirpation of its roots, equally tenacious in texture and life, and enduring several years, is no small problem in badly infested fields. Its habit would seem to indicate its derivation from some one of the "long" varieties of the cultivated plant.

Of other cruciferous weeds, the hedge mustard (*Erysimum officinale*) is somewhat troublesome at times; the shepherd's purse (*Capsella*) is well acclimated but hardly obnoxious. Of native crucifers, the only one that maintains its place among cultivated crops with some tenacity

is the *Tropidocarpum gracile*, which finds improved conditions of existence in the irrigated districts of the upper San Joaquin Valley.

Of other cultivated plants that maintain themselves by roadsides and elsewhere in the open country in suitable ground, the *celery*, *carrot*, and *fennel* are conspicuous. The tall and dense bushes formed by the latter, even on well-trodden roadsides, recall the mention of fennel thickets, dreaded as the lurking places of wild beasts by travelers, in the coast region of Asia Minor. The Fuller's teasel, likewise, has escaped from cultivation, and forms a serious pest at some points.

Of weeds conspicuous on the Atlantic side and almost unknown as such in California, the entire series of *Polygonums* is perhaps the most striking example, excepting only the *P. aviculare*, the knot-weed or bird-grass, which is probably more troublesome here than anywhere else, the rainless summers being nowise against its full enjoyment of life, and in the prevailing absence of summer cultivation, enabling it to develop into gigantic wheel-shaped specimens, as much superior in size to their eastern brethren as are the proverbial California pumpkins. It is, however, a more or less acceptable pasture plant for cattle during the dry season. By ditches and in meadows a few scattering plants of *Polygonum lapathifolium*, *Pennsylvanicum*, and a few others are occasionally seen; but they do not maintain themselves and do not spread into the cultivated fields.

Of their near relatives, the *docks*, however, there are several that count among the more troublesome invaders. While *Rumex sanguineus* and *obtusifolius* are hardly more often seen than are the *Polygonums*, three others—*R. crispus*, *pulcher*, and *acetosella*—are common and extremely tenacious of life, sprouting up from their roots, cut by the last cultivation in May, at any time during the dry season, and seeding quickly and abundantly.

Of *Amaranths* it may in general be said that they flourish in the fields of California as well, or even better, than on the Atlantic side, although somewhat changed in habit. The *A. retroflexus*, as troublesome in California vineyards as among the corn and potatoes of the Prairie States, forms here mostly a flat, wheel-shaped mass, from which the ground squirrel, stooping down, gathers its winter hoard. The *A. albus* (white pig-weed) maintains very nearly its eastern aspect.

Of *Chenopodiums*, *Ch. album* and *bonus Henricus* are almost, if not quite, as familiar as in the East and in Europe; *Ch. vulvaria* likewise is found, but less generally diffused.

Portulacca oleracea, so common and troublesome in Eastern and European gardens and fields, has appeared in a few localities, but although doing well, has made no headway as a troublesome weed. The altered aspect of its fleshy leaves, which become much reduced in size and almost terete under conditions of extreme drought, so that the thick red stems resemble a group of stout radially-disposed worms, suggests a marked adaptation to environments.

The native *Claytonia perfoliata*, although somewhat persistent among the grass in moister ground in spring, hardly maintains itself against regular cultivation. But its pretty relative, the *Calandrinia Menziesii*, does not give up so readily and may be seen covering the ground in orchards and vineyards in the coast region, forming a beautiful carpet of purple that attracts attention from afar. Its vegetative duration is too short and its root system too light to render it troublesome; but the multitude of its shining black seeds render it difficult of extirpation.

Premising the above as a preliminary sketch of "the situation" in California in the matter of weeds, I shall discuss the remainder under their respective orders, in the usual sequence.

Of the *Caryophyllaceæ*, the most universally diffused and quite troublesome member is *Silene gallica*, which seems to be able to withstand the most severe aridity attained in the lowlands of California; at least, in the central portions of the State.

Stellaria media (chickweed) is among the most persistent of summer weeds in cultivated vineyards and orchards; while in the spring *Spergula arvensis* (spurry) takes possession of the moister grounds in the coast ranges, as well as in the Great Valley.

Mollugo verticillata is seen sporadically, but is not as troublesome as in Eastern corn fields.

Of the *Papaveraceæ*, the *Eschscholtzia Californica* maintains itself somewhat tenaciously in pastures, but hardly in regularly cultivated ground. Yet in grain fields, where its spring bloom has been prevented by cultivation, it will very commonly recoup itself by a copious autumn florition, the seeds of which serve to restock the ground promptly and thickly. Thus it forms large areas of flaming orange on the outskirts of growing towns, where the ground has ceased to be cultivated with regularity.

Of the *Malvaceæ*, almost the only member that is really a weed is the *Malva parviflora*, although a few others are locally complained of. This is the "Malva" par excellence, regarding the extirpation of which many newspaper articles are written without reaching any very definite conclusions with regard to its repression on ground favorable to it. It is at home in the heavy black clay or "adobe" soils of the Coast Range, where it will grow to four and five feet in height under favorable conditions, but on roads will form decumbent wheel-like masses resembling those of its Eastern congener, the *M. rotundifolia*. Its seeds, borne in the greatest profusion, will germinate with the most surprising readiness, even when the plant is killed quite green; the seedlings will be found coming to the surface from the depths of the soil-cracks in midsummer, and mature an abundance of seed under the most discouraging conditions. It is one of the most persistent weeds the California farmer has to combat, and its extirpation from ground once well stocked with it seems almost hopeless. Some have recommended it as a forage plant, but few cows will touch it so long as anything else is in sight.

The *Geraniaceæ* are prominently represented by the *Erodium cicutarium* and *E. moschatum*, both commonly known as alfilerilla or alfileria, and both widely diffused. The first named is, however, not only the one that has been carried even to the remotest districts of the State, but is distinctively the species possessing the value as a forage plant, which is sometimes erroneously assigned to both. For the *E. moschatum* is so distinctly of musky flavor, that, like the *Anthoxanthum* among the grasses, it is eaten only in limited quantity by any animal as a flavoring; an alfilerilla pasture once overrun with the musky species ceases to have much value, while in heavy, rich soils the more valuable kind is often completely "run out" by the other. In light, sandy soils the *E. cicutarium* is more likely to hold its own. Its long red tap-root will descend for moisture to the depth of several feet, and will keep green when everything else that is of value as forage is dried up. The rosettes formed by its radical leaves lie close to the ground in winter

and resist even heavy frosts without injury. Both plants are regarded as marks of a rich soil; and in such soils the task of keeping them in check is indeed a serious one. For the seed will continue to germinate in the driest and hottest times of midsummer, after the land is "laid by;" and the costly operation of hoeing alone can master it at that season. The propagation of the alfilerilla as a pasture plant is rendered difficult by the nature of the seeds with their long, spirally-coiled awns (styles); and in certain sandy soils of South California its spread is arrested by the red ant, which gathers the seeds in its burrows, leaving conspicuous piles of the awns outside around the hills.

Of other *Geraniaceæ*, the *G. Carolinianum* is the only one that occasionally appears as a weed, but it is easily conquered.

Oxalis corniculata is locally a very persistent weed, resisting the summer's drought to an extraordinary degree; but it is not generally distributed, though more common in Southern than in Northern California. No other "sheep sorrels" have reached the State.

The western poison "oak," or rather sumac (*Rhus diversiloba*), is a very persistent invader of pastures on which it formed part of the original growth, and keeps sprouting up from fragments of rootstocks remaining in the soil, for years. In company with the brake fern (*Pteris aquilina*) it is usually the last of the native vegetation to be subdued by cultivation, both in the coast ranges and in the foothills of the Sierra Nevada.

Of the great *Leguminous* family, only four members can be said to be generally obnoxious to farmers, viz.: the burr clover (*Medicago denticulata*), the sweet clover (*Melilotus Indica*), the sand lupin (*L. formosus*, Greene), and the native licorice (*Glycyrrhiza lepidota*). It is true that some of the many native clovers, though mostly annual, persist for a while among the grain; but they soon disappear from cultivated fields and only remain in pasture grounds, where they are all welcome.

But the burr clover, apparently one of the earliest European introductions, is of a very different temper. Although an annual, its long, wiry, deep-going roots enable it to survive repeated croppings, even unto another season. Under the influence of somewhat generous spring rains, its usually decumbent stems will become assurgent and clothed with luxuriant foliage, forming a heavy, dense mat on the ground, six to ten inches thick, and apparently a most inviting pasture. But its inherent bitter taste prevents any serious damage being done to it by pasturing cattle, which pick the early grasses in preference. Thus the clover is allowed to mature its coiled pods, armed with hooked bristles, and borne in such abundance that they often form a layer over an inch high where the plant, after the cessation of rains, has disappeared before the summer "northers," only a few wiry stems remaining. These burrs form a highly important ingredient of the "dry pasture" in the coast ranges, where cattle get fat on ground that looks, to the newcomer, as barren as burnt prairie on the plains. Sheep, of course, also thrive on the pods; but the damage done to the value of their fleece by the inextricable burrs is so great that burr clover pastures are sedulously avoided by the sheep men.

But during the summer drought this plant changes its nature to suit the altered conditions, and where the ground is cultivated the seed of the same season soon germinates and a second crop comes up to worry the cultivator. It does not take the insidious little plant long to develop

into wheel-shaped mats of all sizes, lying flat on the ground, with minute leaves only, and soon covering themselves with closely packed burrs in great profusion. At this time the stems are wiry and tough, and only a very sharp hoe will cut either root or stem. But the seeds acquire germinating power so quickly, that unless eternal vigilance is exercised, a close mat of young plants will be found in spring where an apparently wretchedly depauperated specimen seemed hardly to maintain life the previous summer. It appears as though the burr clover had found in California conditions more favorable than anywhere else in the world.

The yellow melilot, also, appears to find a most congenial home in all the richer soils, where moisture is not too deficient. Thus, it grows not only on the banks of brooks and ditches in the coast ranges, as well as in the Great Valley, but is also found on the roadsides and in the cereal fields, completing its growth and fruiting, like the latter, in the spring or early summer. Hence, when the cereals are cut for hay, the melilot often goes in as a flavoring ingredient, to an extent which renders the hay distasteful to horses, at least. Worse than this, it is harvested with the grain, and, if left even in the sheaf for any length of time, so flavors the grain that the flour made therefrom has a distinct "gingerbread" flavor, that is strenuously objected to by millers, both here and in England, and has caused serious discounts upon many a cargo of wheat. Where this plant is mixed with the grain, it is very important that the reaping, thrashing, and winnowing operations should follow each other as quickly as possible; as in practice is done by the "combined harvester and thrasher." Even then, if any considerable amount of the seed is left with the grain, the gingerbread flavor will gradually communicate itself to the wheat grain, and through it to the flour.

The sand lupin is naturally at home on deep, sandy soils, both in the coast ranges and in the Great Valley of California. In these it extends its long, tough rootstocks in all directions, and sometimes forms a matwork of roots that renders it difficult to keep the plow in the ground. As even short pieces of these will root, this lupin—one of the handsomest of its tribe—is a very unwelcome denizen and difficult to extirpate. Its assurgent stems form large, low bushes, brilliant with purple flowers, and will shade out every seedling within its reach. In heavier soils it is much more easily dealt with.

The native licorice shares with the lupin, as with its Asiatic relative, the possession of long subterranean stems, of which even short pieces will sprout into independent plants. It is especially troublesome in the lighter alluvial soils, in which it finds sufficient moisture throughout the season, and which are its natural habitat. But it gathers fresh strength under cultivation, and if not summarily dealt with when the land is first broken, will be much more difficult to eradicate after the fragments of its rootstocks have been further disseminated by the plow. Fortunately it is not as common in California as it is in some parts of Oregon and Washington, where it is known as "Buffalo brush," and covers large areas almost exclusively.

The *Rosaceæ* furnish no plant that could properly be classed as a weed in California, save perhaps that the *Chamæbatia foliolosa*, the procumbent "tar-weed" of the Sierra foothills, sometimes persists for some years after the land it covered has been taken into cultivation.

Of the *Onagrariaceæ*, *Oenothera ovata*, the stemless evening (here more

properly "morning") primrose, is somewhat persistent in pastures, and if not suppressed will gradually shade out the grasses with its dense rosettes of leaves. It plays the same part that the several plantains do in grass lawns; but its beautiful and abundant flowers plead for its toleration, as do those of the dandelion in Europe and the East. *Epilobium paniculatum* locally invades the moister fields, but is not very persistent.

Of the *Cucurbitaceæ*, two species of *Megarrhiza* (*vulgo* "big root"), occurring both in woods and open grounds in the coast ranges, retain their hold on cultivated lands, as well as pastures, for a number of years, owing to the enormous tubers which, lying from two to four feet below the surface, can be reached only by laborious digging. Persistent cutting-off of the shoots will gradually exhaust the tuber, but if allowed to grow even a short time during each season, it will continue to send forth its succulent climbing runners almost indefinitely.

The *Cucurbita fœtida* (*C. perennis*, Gray), the calabazita of the Mexicans, is common in open grounds in the southern half of the State, and retains a place in the fields with some tenacity, on account of the multitude of its gourds, and the protection their hard rind affords to the seeds. It covers the ground in wheel-shaped masses, eight to twelve feet across, and of course is a very unwelcome visitor in all cultivated grounds. But by cutting off the (perennial) root-crown, and picking up the gourds for a season or two, it can be readily extirpated.

None of the numerous native species of the *Cactaceæ* trouble the husbandman after they have once been removed from the ground; but the latter task is certainly one of the least agreeable. Ordinarily the fleshy stems are left to die and dry up in piles, which are fired as soon as it can be done effectively.

Of the large and copiously represented family of the *Umbelliferæ*, scarcely one can count as a seriously obnoxious weed. The fennel, heretofore mentioned, is a hardy roadside weed, but is easily dealt with in cultivation. The caraway makes no headway; the anise and coriander retain a place in fence corners, but do not spread. The celery seems to have escaped from cultivation into wet grounds, and sometimes covers them thickly, but quickly yields before culture. The carrot is abroad in woodlands and pastures, but is not troublesome. Of the numerous native species, *Sanicula Menziesii* and *bipinnatifida* are apt to maintain themselves in pastures for some time, as do certain species of *Peucedanum* and *Caucalis*, as well as the large *Heracleum lanatum*. But none of these can be accounted serious pests in cultivated ground.

Of the *Rubiaceæ*, the native *Galiums* are quite innocent of harm. *Diodia*, so troublesome in the Cotton States, is occasionally seen, but makes no headway. The *Rubia tinctorum*, however, spreads energetically in heavy soils, and would doubtless prove a serious pest were it to escape from cultivation.

Of the *Dipsaceæ*, as stated above, the Fuller's teasel has become a common roadside weed in the Bay region, and runs riot in waste grounds; it could doubtless be cultivated to great advantage in this genial climate, could a market be found for it. The garden Scabious, also, has escaped, and frequently occupies the ground on dusty roadsides.

The *Composite* family furnishes some of the most obnoxious and interesting weeds, and a considerable number. Broadly speaking, there are six chief introduced species that give serious trouble, to wit: First, and worst

of all, the *Centaurea Melitensis* and *solstitialis*, introduced from Southern Europe, and almost universally diffused under a variety of names; second, the *Cotula vulgaris*, a comparatively recent arrival; third, the *Silbyum marianum;* fourth and fifth, the two cockle-burs, *Xanthium strumarium* and *spinosum*. To these may be added as of less importance, although likewise widely diffused, the *Senecio vulgaris*, *Sonchus oleraceus*, and *Erigeron Canadense*. All of these well known weeds may be seen at their best in the fields and pastures of California, but little changed from their Eastern or European habits, but exhibiting a resistance to heat and drought that would hardly have been looked for in their native climes. Alongside of these foreign invaders, a few native composites play a subordinate and relatively innocuous part.

The two *Centaureas*—the tocalote of the Mexicans, and the Napa thistle and prickly tar-weed of the Americans—deserve more than a passing notice as being, with the black mustard and the "barley grass" (*Hordeum jubatum*), the most formidable weed pest for both fields and pastures, particularly in the central and northern parts of the coast ranges. Starting in early spring, the *Centaurea Melitensis* especially will mature seeds in May; these, or any others, will germinate again under conditions of heat and dryness that will permit no other seed to move; this second generation again runs to seed rapidly, and may in its turn be succeeded by a third, maturing its seed in December. The wiry tap-root, penetrating deep into the soil, requires a sharp tool to cut it. The tocalote is thus a weed that, unlike almost any other within the State, gives the farmer no summer rest where it is once well established. In pastures it is even a worse pest than in cultivated fields, as it will take possession of the ground so soon as even a casual overstocking occurs, being able to avail itself of any chance that may occur throughout the season. It quickly and completely runs out the native grasses, and it is impossible to restore the grass without previous cultivation. For, although the plant is an annual, if cut anywhere above the root-crown, it soon sprouts decumbent branches, that will bloom and fruit under the very tread of cattle; and if again cut, the same process will be repeated the same or the following year. The slender, sharp spines of the involucral scales (quite strong and long in the true *C. solstitialis*) render the plant doubly obnoxious to the pedestrian when dry, while in the green state, the viscous tomentum of stems and leaves soils the clothes. In grain fields it sometimes covers the ground completely after harvest, seeding it thoroughly for the coming season.

The *Cotula* comes next to the tocalote as the enemy of overstocked pastures. It is not yet widely diffused, and has reached the borders of San Francisco Bay within my own recollection—about ten years ago, when I first observed it on the road from Oakland Point to Berkeley. Within two years it reached this place, and then, favored by the trade winds from the west, it quickly ascended the Coast Range, and now disputes precedence with the tocalote, up an elevation of nearly one thousand eight hundred feet. As its vegetation is somewhat earlier than that of the thistle, it shades out the latter during the early part of the season; but later the tocalote takes its turn, and between the two the hill pastures are left in a sorry plight. The "May weed" does not, however, occupy waste places in this region as generally as is the case in the Cotton States; its growth is low, and, as there is only one generation each season, it seems that it might readily be kept in check on cultivated ground, which as yet it has not invaded to any great extent.

The *Silbyum marianum* has in the Bay region become a common roadside weed, whose masses of handsomely veined foliage surpass in beauty many a carefully nurtured plant, but present an aspect of ragged dilapidation after the (annual) plant has completed its vegetation and sends its hairy-tufted akenes flying all over the country. Curiously enough, the *Silbyum* was for several years mistaken for the Canada thistle, and the legislation regarding the latter was partly enforced against it until the mistake was brought out in a lawsuit for neglect to comply with the law. Systematic mowing at the time of heading soon disposes of the plant, but when it has once gained possession for the season, it is hard to subdue, and shades out everything else.

The true Canada thistle was at one time imported into the State, and took possession of some land near Chico, Butte County, but was promptly recognized and subdued.

An experimental planting of the *Carduus benedictus* in the University garden revealed such dangerous qualities as a rapidly spreading weed that it was promptly extirpated.

Of the two *Xanthiums* mentioned above, the *X. spinosum* especially has become ubiquitous in the State, at least from Cisco to San Bernardino. Roadsides and fields are equally favored by it, and no summer drought or heat seems to affect it materially. Like the "black" cocklebur, it differs from the eastern form only in a lower and more spreading habit; and both are redoubtable weeds if neglected.

The entire tribe of rag-weeds (*Ambrosia*) is absent from the California list of weeds. The native *Franseria* is innocent.

Sonchus oleraceus, the milk thistle, and *Senecio vulgaris*, thrive as well in California as anywhere in the world, and are found throughout the settled portions of the State. The *Senecio* will germinate in the middle of the summer's drought almost as well as the *Centaureas*.

Erigeron Canadense affects chiefly the irrigated lands, and there demonstrates an unexpected resistance to even very strong "alkali," such as few useful plants could resist. In Fresno and Tulare Counties it reaches the height of eight feet easily, and forms thickets not pleasant to penetrate. In unirrigated lands it rarely becomes troublesome, and is of small stature, but nevertheless maintains itself fully where once established.

Cichorium intybus obstinately retains possession of fields where it has been cultivated, and spreads more or less, but outside of such cases the chicory can hardly be considered troublesome.

Matricaria discoidea is extensively diffused in the State, and lines the roadsides all over the Bay country, emitting its pleasant fragrance in the hot sun. *Chrysanthemum leucanthemum*, the ox-eye daisy, has gained a foothold in a few localities in the same region, but is not troublesome, and does not seem to spread rapidly.

Of native composites, the "tar-weeds" are the most objectionable; not so much because of their persistence as weeds as on account of the inconvenience caused by their viscid secretion, both to the person and clothes of the farmer, and to certain products. *Madia sativa* is the most generally obnoxious, both because of its almost universal occurrence in fields and roadsides, its extremely abundant secretion, and its disreputable aspect when covered with dust. An expensive bath of alcohol alone seems capable of removing the resinous slime from the injured clothes.

Several *Hemizonias* are hardly behind the *Madia* in these respects, and several add to it a strong and sometimes disagreeable odor. Among these the *H. elegans* stands foremost, but this species is not often found in cultivated fields. The *H. luzulæfolia*, on the other hand, exhales a spicy odor of myrrh which is wafted over the harvest fields in July and August, and in a measure condones the disagreeable qualities of the plant, which really hurts the grain but little, attaining its growth after the crop is off the ground, and then seeding the latter most thoroughly when plowing cannot be done on account of the dryness of the soil. Several other species, however, are not so innocuous, as they grow up very rapidly among the grain while in milk, rendering it impossible to harvest without commingling it with the grain and then spoiling both straw and grain with its resinous exudation. They often form impassable thickets along the irrigation ditches.

The wild sunflower (*Helianthus annuus* or *lenticularis*), occurring naturally on rich and moderately moist soils, finds greatly increased opportunities for development when the land is cultivated, and sometimes covers the ground first broken completely, in defiance of crops sown. It is not, however, very persistent, and repeated mowing soon diminishes it to an easily manageable condition. But its complete extirpation is quite difficult. *H. Californicus*, occurring only in low, wet lands, is not very troublesome.

The place held in Europe and the East by the dandelion is measurably filled in California by several large-flowered species of *Troximon* (popularly called dandelions), and *Hypochæris*, whose feathered akenes fill the air in summer. They hardly invade the cultivated ground, but chiefly pastures and lawns. The true dandelion was at one time introduced as a matter of sentiment by an admirer, but showed such wonderful powers of development that it was, with some expense, extirpated from the threatened lawns.

Of other composites that invade the fields more generally but without doing any material damage, the beautiful *Layias* deserve mention. They make the ground gay beneath the half-ripe grain, and afterwards develop more fully. The *Achyrachæna mollis*, very inconspicuous while in bloom, sometimes forms a dense mat beneath the grain, and after harvest covers the field and fills the air with its beautiful silver-winged akenes.

Matricaria occidentalis invades the grain fields of the Bay region to some extent, but is not seriously troublesome.

The *Primulaceæ* furnish only the ubiquitous *Anagallis arvensis*, but this attains a degree of development which, from its prevalence in the moist European climates, would hardly be suspected. From early spring until the beginning of winter the multitudinous seeds of this little plant germinate, from the surface of moist soil or from the depths of that which is parched and hot, and with a tenacity of life worthy of a better cause. With the two *Centaureas*, the *Stellaria* and the *Erodium cicutarium*, it constitutes a group of weeds that form an exception to the prevalent rule, that after the cessation of rains the California farmer may consider the weed fight over for the season. In the northern part of the State its flowers have the usual dull red tint; in the southern their color is frequently purple or almost blue, and is so little recognized as the Old-World "Pimpernel" that it goes under the name of "poison chickweed."

Of the *Apocynaceæ*, *A. cannabinum* invades pastures from the woodlands in the northern part of the State, but does not become troublesome south of Oregon and Washington.

Asclepias fascicularis maintains a place in cultivated fields of the "black adobe" character with some tenacity; *A. Fremonti* and *eriocarpa*, and locally *Gomphocarpus tomentosus*, maintain themselves in pastures, to the occasional detriment of sheep and cattle that are tempted to vary their dry summer diet with something green, and are poisoned by eating the leaves of these milk-weeds.

Of the *Gentianaceæ*, *Erythræa Muhlenbergii* keeps a place even in cultivated fields to some extent, and very commonly in pastures.

Of the numerous *Gilias*, only *G. squarrosa* rises to the dignity of a weed, both in pastures and cultivated fields, where its spinous leaves and bracts, and, above all, the intense odor that has given it the name of skunk-weed, render it obnoxious. Its viscous tomentum, covered with dust, gives it a forlorn aspect, and one sees with surprise the small, blue, starlike flowers amid this mass of dirt, spines, and fetor.

Phacelia tanacetifolia is the only weed from among the numerous *Hydrophyllaceæ*. Its prickly-hirsute stem and foliage render it an uncomfortable invader of the fields, and there is no compensation in its dull, yellowish-white flower-coils.

Among the *Borraginaceæ* two native *Amsinckias*—*A. intermedia* and *lycopsoides*—are truly troublesome in the coast ranges, maintaining themselves on the heavier clay soils which they naturally occupy, despite of cultivation and to the material injury of grain crops, with which, in many seasons, they share the ground evenly or prevalently. From the clinging quality of their hooked, hirsute tomentum, the *Amsinckias* have received the inappropriate name of "yellow tar-weed," although entirely innocent of resinous qualities. The nutlets accompany the bristly calyx on its migrations in the hair of cattle.

The *Convolvulaceæ* supply only two obnoxious members, one native—*C. Californicus*—and the European *C. arvensis*. These are not hurtful as "bind-weeds," but simply on account of obstinately holding their ground against culture plants by dint of their long rootstocks, that penetrate the ground to great depths, and which it is impossible to kill otherwise than by exhausting them—keeping the persistently reappearing tufts of foliage constantly cut during at least one season. The native species, which is erect, without creeping stems, is especially hard to subdue in the "black prairie" or adobe soils of the coast ranges, and its pretty white flowers adorn many an abandoned orchard in the Bay country. The *Convolvulus* is the most dreaded of the perennial weeds.

The *Cuscuta trifolii* is naturally a much dreaded pest in a country in which alfalfa is so important, and annually makes its appearance here and there, but is promptly checked by the simple expedient of close pasturing for at least one season. Alfalfa seed is usually required by the purchaser to be warranted "free from dodder."

Another dodder (*C. salina*) makes itself conspicuous in the coast marshes bordering San Francisco Bay, by large gold-tinted patches in the samphire growth; but of course it is otherwise innocuous.

Of the *Solanaceæ*, *Solanum nigrum* appears as a weed in waste places or fields, without being troublesome. The *Datura stramonium* has been introduced, but makes little headway, and is rare, while the native *D. meteloides* maintains itself obstinately against cultivation in the Great

Valley and in South California, taking the place of the "Jamestown weed." Its range is nearly coëxtensive with that of one of the native tobaccos,

Nicotiana attenuata, whose viscous stems and foliage combine with an unpleasant odor to render it objectionable in the fields it invades.

Of the *Scrophulariaceæ*, the only weedy accession from the outside is an occasional occurrence of *Veronica peregrina*. *Scrophularia Californica* is locally troublesome; *Mimulus lyratus* is an obstinate, but hardly noxious, guest on the black lands of the Bay region and elsewhere. The most troublesome member of the family is *Orthocarpus purpurascens*, which not only disputes the ground with grain in the coast ranges, but must be strongly suspected of adding injury by semi-parasitism, etiolating the remnant of grain stalks. The same must be suspected as regards several others of the same genus that are frequent among the grain and in pastures in California, as well as of *O. campestris* of Oregon and Washington.

The cosmopolitan *Brunella*, though occurring in the mountain pastures of Northern California, obtains no foothold south of the Oregon line. *Stachys bullata* is locally troublesome in the Coast Range valleys; the intensely-scented *Trichostema* (camphor-weed) maintains itself in the cultivated fields of the warmer parts of the State as on its original ground, defying heat and drought, and playing the part of a "tar-weed" very successfully. But no other labiates can be counted as weeds.

The *Verbenaceæ* are represented only by *V. officinalis*, which, in the irrigated lands of the Great Valley and lower foothills, attains a vigorous development.

Of the *Plantaginaceæ*, *P. major* and *mollis* give some trouble in lawns and irrigated grounds, but cannot be considered troublesome. It is quite otherwise with *P. lanceolata*, which, in company with *Setaria glauca*, is the most formidable enemy of the irrigated grounds and pastures in the foothills of the Sierra, and more or less in the adjacent portions of the Sacramento Valley. This plantain frequently shares the ground evenly with the grain, and, in company with the *Setaria*, forms steadily increasing patches in the alfalfa fields, until the whole ground is taken. Such ground is difficult to reclaim from weeds, so long as field crops are grown.

In connection with the *Polygonaceæ*, it should have been stated at the beginning of this paper that the native *Rumex hymenosepalus*, whose tannin-bearing root is becoming an article of commerce, will persist quite obstinately in the sandy lands of the South, because of its many long, fleshy tubers that are not easily killed. Among the *Chenopodiums*, also, *Ch. ambrosioides* should have been mentioned as a common roadside weed, found in fields and waste places.

Urtica holoserica, the tall, stout native nettle, makes itself disagreeably conspicuous in low grounds; while *Urtica urens* is a common invader of cultivated grounds all over the State.

Of the *Euphorbiaceæ*, it is chiefly the decumbent tribe that represents the *Euphorbias* proper in the fields; notably *E. serpyllifolia*, of the East, and *albomarginata* and *ocellata*, as natives. All these are popularly credited with curative properties against rattlesnake bites. *E. lathyris* has locally escaped from cultivation, and is periodically brought forward as a much needed remedy for the troublesome "gopher," which, in sandy lands, it really seems to abate materially, probably through the poisonous properties of its pleasantly-tasting seeds.

The most universally diffused weedy member of the order, however, is the *Eremocarpus setigerus*, a broad-leaved, hirsute, spreading annual, commonly known under the name of turkey-weed. While it prefers sandy soils, and is therefore more especially at home in the San Joaquin Valley, it is also found throughout the Sacramento Valley and within the coast ranges, from Mendocino County on the north to San Diego on the south. It does not even omit the Mojave Desert, but there changes its dichotomous spreading habit to an erect one, and appears in large patches densely crowded with almost unbranched stems, as much as three feet in height; suggesting the use of its strong and abundant fiber for industrial purposes. The extremely irritating nature of the dust arising from the dry stems when handled would alone probably prevent such use. The extreme resistance of the plant to drought enables it to survive almost any other annual vegetation; but the ease with which it is killed, even by a kick at the root-crown, renders it much less objectionable than most other "summer weeds."

Of the *Monocotyledons*, the true grasses only furnish really noxious weeds.

Anemopsis Californica, the yerba mansa of the Mexicans, maintains itself against cultivation in moist grounds with some obstinacy, but is not permanently troublesome.

Sisyrinchium bellum, the handsome blue "star grass," is apt to overrun moist but overstocked pastures, and is sometimes not easily subdued.

Oddly enough, one of the "California lilies," the pale blue *Calochortus invenustus*, Greene, is a veritable weed in some of the warmer parts of the State, where it persists in grain fields, though without material damage. A *Zygadenus* is charged with poisoning lambs and their hungry mothers in the early spring, in Northern California and Oregon.

Of the *Juncaceæ*, only *J. effusus* can be accounted as invading cultivated fields, in regions where it forms the natural growth in the woodlands.

None of the *Cyperaceæ* are at all troublesome in California.

Of weed grasses, the troublesome chess (*Bromus secalinus*) is found here and there, as an importation with seed-grain or packing-straw; but it utterly fails to gain a foothold as a weed. Its place is, however, very successfully occupied by the corresponding plant of Europe, the darnel (*Lolium temulentum*), which not only holds in the cereal fields a place similar to that held by the chess in the East, but is in addition charged with the same sin of transforming itself at will, in unfavorable seasons, into the very grain of which it has usurped the place—wheat, barley, oats, or whatever the crop may happen to be. The echoes of warm discussions on this issue, both in journals and in agricultural clubs, have hardly yet subsided, and there remains many a staunch believer in the changeling supposed to perform such surprising feats. Not the least amusing feature of this discussion is that Darwin was repeatedly cited as supporting and proving the occurrence of such transformations.

Lolium perenne, mostly in its Australian form, maintains itself sturdily against the summer's drought so far as its roots are concerned, and if cut will grow flower-stems three, and even four times in one season; still, it is not difficult to extirpate when so desired. *L. multiflorum* (annual) is common on roadsides, but is hardly troublesome.

Bromus mollis finds the climate much more congenial than does *B.*

secalinus, and with *B. sterilis* may be classed as a weed-grass common on roadsides and in neglected fields. But it has attained a wide importance as a more or less welcome successor of the native grasses on natural pasture grounds, so completely adapted to the Coast Range climates that it may be found waving on the slopes as thickly massed as though sown on purpose. Locally it has been thus used, and is likely to become more popular, since it has been found to be effectual in driving out the most dangerous enemy among the grasses of both pastures and fields, viz.: the *Hordeum murinum*, variously known as squirrel grass, foxtail, and barley grass. This undesirable immigrant, while affording early green pasture for a short time, becomes a fearful nuisance so soon as its long-awned ears are developed. The bristly awns, provided like the paleæ with retrorse serration, accompany the three-flowered spikelets to the end; and the latter being sharp-pointed at base, adhere to and penetrate almost anything in the way of woolen or cotton materials from the sheep's fleece to ladies' dresses; they work up the nostrils of cattle, and the laborer's sleeves to the neck, and generally make themselves obnoxious to a degree not easily surpassed by any plant outside of the tropics. Although annual, its extirpation has proved extremely difficult; and the advent of a natural enemy in the "soft brome grass" is therefore most welcome.

The wild oat (*Avena fatua*) is so generally diffused, even in the remote portions of the State, that it is commonly considered indigenous, since it is mentioned by the early explorers as covering the hillsides of the coast ranges as well as Sierra foothills. While an unwelcome guest in the grain fields, it is highly esteemed for hay, despite its hirsute glumes that, when too ripe, sometimes give trouble in "choking" cattle not used to it.

Of the numerous paniceous grasses that trouble the Eastern farmer—the barnyard grass, crab grass, feather grass, and the several *Paspalums*—not one seems to gain a permanent foothold in the fight for existence. Only the purposely introduced *P. halepense* (Johnson grass) has in some sandy soils proved an almost ineradicable pest. The *Setaria glauca* is a terrible pest in the irrigated alfalfa fields of the foothills, as stated above.

Of the various *Poas*, only the *P. annua* can be counted as at all troublesome. The pestilent *P. Eragrostis* (*Eragrostis vulgaris*) does not maintain itself where introduced; and of the wild grasses, including those comprehended under the general name of bunch grasses (mostly species of *Festuca* and *Poa*), not one troubles the farmer save by the difficulty with which the turned-up rootstocks decay under the arid climatic conditions.

The most widely troublesome native grass is the *Distichlis maritima* ("alkali grass"), which long maintains itself in "alkali" ground, particularly in the lighter soils, in which its long rootstocks penetrate to depths of several feet and propagate from any fragment of a few inches, especially in irrigated lands; resembling, in this respect, the Bermuda grass as known elsewhere. The latter, however, can in California do no more than hold its own where planted, except on the borders of ditches; for the reason that during the dry summer its runners are unable to cast root, thus preventing its spread.

The eagle *fern*, common on the northward slopes of the coast ranges, maintains itself somewhat obstinately here, as it does in Oregon and Washington; but persistent cultivation for a few years overcomes it.

While the above enumeration seems, at first sight, to present the weed question as somewhat formidable in respect to the number of species concerned, yet as a matter of fact, "getting into the grass," that constant bugbear of the Eastern farmer, confronts the California cultivator only in exceptional seasons; and with ordinary and intelligent care, adapted to the nature of the local weeds, he can usually rest from the weed war from June to November, or whenever the rains happen to set in. In the older cultivated regions, in fact, the extirpation has frequently been so complete that in the absence of the supply of vegetable matter usually furnished by plowing-in of weeds, the green-manuring of the clean orchards and vineyards is being seriously taken in hand.

SOME BERKELEY WEED-SEEDS.

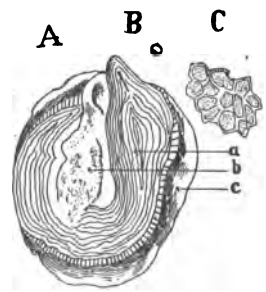
Graduating Thesis, by HUBERT P. DYER; Class of 1890, University of California.

[NOTE.—The descriptions and figures of weeds and weed-seeds, given below, form part of a work very needful to be done for this State, and the doing of which by students has been specially encouraged, because the time of the regular staff does not permit of its performance to any serious extent thus far. The existing works on the subject figure but few of the weed-seeds most interesting to the California farmer, and in the exclusion of which from the seeds he sows he is especially interested; hence, the determination of the purity of what he buys is rendered doubly difficult. The paper here presented is admittedly a mere fragment, but valuable as far as it goes. As time progresses we hope to increase, and ultimately complete, the description and figuring of California weeds and weed-seeds.—E. W. H.]

CRUCIFERÆ. (Mustard Family.)

This family furnishes those pests, the common mustards, and also the wild radish, a seed of which is shown in the drawing.

Raphanus sativus.—This is a coarse annual or biennial, and, like most of our worst weeds, is an introduced species escaped from cultivation. It can be easily recognized by its resemblance to the domestic radish

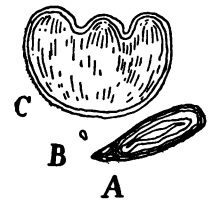


Seed of Raphanus sativus.

A. Position of the embryo seen in section. *a.* The embryo: yellow, clear. *b.* Yellowish, granular: starch. *c.* Exterior of seed. *B.* Natural size. *C.* External markings on seed-covering; color dead brown.

when "gone to seed." Its seeds ripen in the middle of the spring season. The plant is difficult to eradicate, because it sprouts from the roots when cut.

Capsella Bursa-pastoris, or "Shepherd's Purse."—This is a very common annual, found growing from two inches up to almost two feet in height, in gardens, along roadsides, and in other carelessly tended spots.



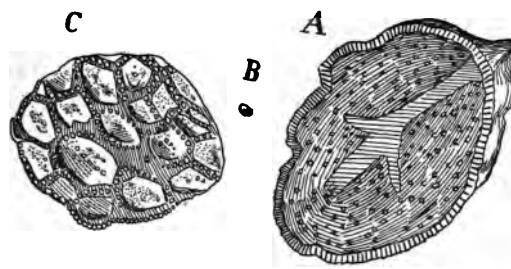
Seed of Capsella Bursa-pastoris.

A. Shape and appearance; greatly magnified. *B.* Natural size; color amber brown. *C.* Cross-section.

It has a small white flower, radiating leaves, and thin, triangular fruit-pods. By good early cultivation it is readily killed.

PAPAVERACEÆ. (Poppy Family.)

Eschscholtzia crocea, or California Poppy.—This is a showy plant, hardly to be ranked as a weed, although reappearing persistently when culture ceases.

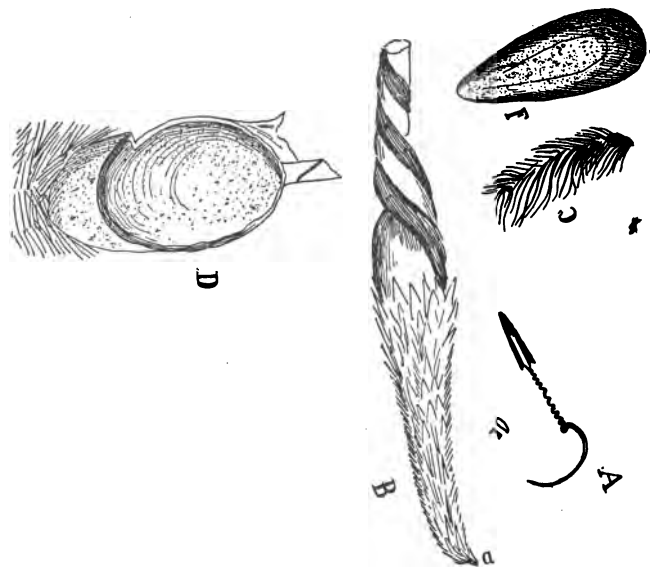


Seed of Eschscholtzia crocea.

A. Seen in cross-section. *B.* Natural size; color dull brown. *C.* External markings.

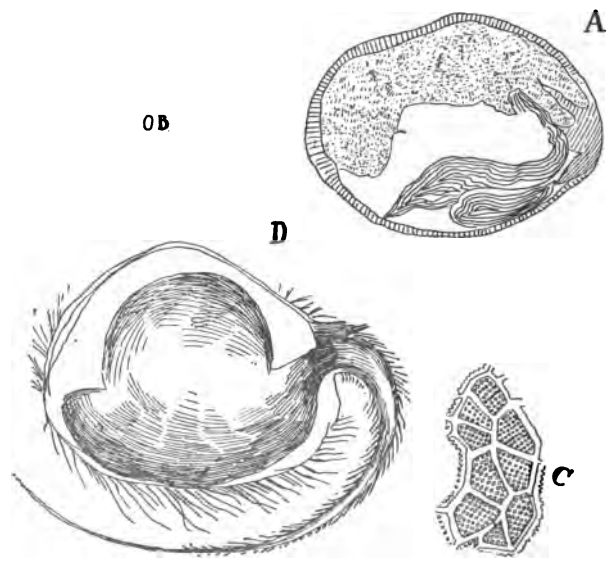
GERANIACEÆ. (Cranesbill Family.)

Erodium moschatum, or "Musky Filaree."—In many places this species is displacing the *E. cicutarium*, the true alfilerilla, a valuable forage plant; on the University grounds it becomes a very obnoxious weed. Its propagation is assisted by the peculiar structure and form of the seed-vessel, which, under the alternate moisture and drought of our seasons, twists about and forces the seed into the ground.



Seed of Erodium moschatum.

A. Natural size of seed-vessel. *B.* Showing seed-vessel enlarged. *a.* Seen in *C* enlarged. *C.* Barb of seed-vessel. *D.* Upper end of seed-vessel. *E.* Natural size of seed. *F.* Seed enlarged; external markings, very minute dots.



Seed of Geranium Carolinianum.

A. Seen in cross-section through center of seed. *B.* Natural size. *C.* External markings on seed: white ridges between the finely circular-marked spaces, which are black. *D.* Seed-vessel greatly magnified.

Geranium Carolinianum, often called "Carolina Cranesbill."—It is a low (six to eighteen inches), much branched, erect annual or biennial plant, with short-stalked, deeply five-parted leaves, the divisions cut-toothed, and small rose-colored flowers. It is only found occasionally, and is, in consequence, not troublesome. Its seeds are expelled from the seed-vessel by two prong-like springs, which throw the seed out with considerable force.

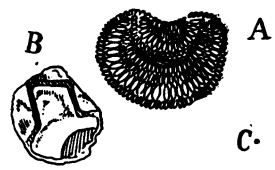
G. dissectum.—Similar to the last, differing in the more sharply pointed foliage, deep purple corolla, and more strongly netted seeds.

Seed of Geranium dissectum.

A. Showing position of seed in pod. *a.* Prong which expels the seed. *b.* Seed in position. *B.* Seen in cross-section. *C.* Natural size.

CARYOPHYLLACEÆ. (Pink Family.)

Silene Gallica.—This is an Old-World weed, widely prevalent and apparently drought-proof, equally in waste grounds and cultivated fields; grows six to ten inches high, with slender, dry, scantily-leaved stems and pale pink flowers, borne on one side. It is a slender, hairy plant, with spatulate leaves. It is not a serious pest, although rather a serious nuisance to smaller cultures; easily killed, but, on account of the multitude of its minute seeds, not easily eradicated.

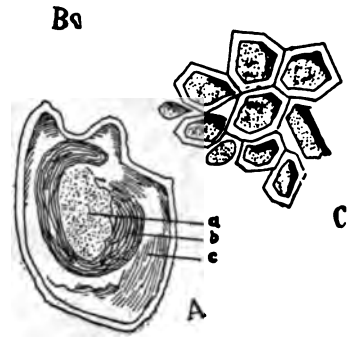


Seed of Silene Gallica.

A. Shape and surface appearance of seed; color black. *B.* Seen in cross-section, normal to *A*. *C.* Natural size.

PORTULACCACEÆ. (Purslane Family.)

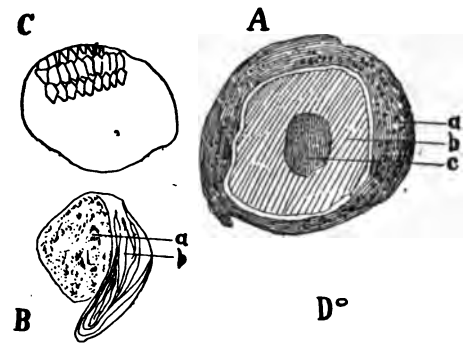
Claytonia perfoliata.—This is a low fleshy herb, with a shield-shaped leaf at the base of a flower stem, bearing small white flowers; called by some "Indian Lettuce." It grows in the spring in cool damp places, with *Stachys bullata* and *Calandrinia Menziesii*. It is not specially troublesome.



Seed of Claytonia perfoliata.

A. Position of embryo, seen in section. *a.* White starch. *b.* Albuminoid substance. *c.* Brown seed-coats. *B.* Natural size. *C.* External markings on outer seed-coat; color shining black.

Calandrinia Menziesii.—This is a low-branching herb, with showy rose-colored flowers; quite common in wheat fields and orchards. The ease with which it yields to cultivation renders it of little consequence, although it is not easy to eradicate it entirely.

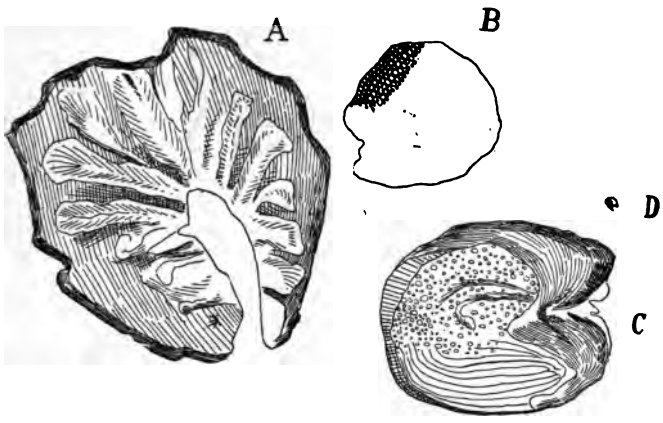


Seed of Calandrinia Menziesii.

A. Seed seen in section. *a.* Seed-coats. *b.* Yellowish albuminoid substance. *c.* White starchy albumen. *B.* Shape and position of embryo. *a.* White starchy albumen. *b.* Embryo, yellowish. *C.* External markings of seed-coat; color shining black. *D.* Natural size.

MALVACEÆ. (Mallow Family.)

Malva parviflora.—This is an introduced plant, very common in cultivated ground, and commonly called the "Malva." In rich, moist soil, it reaches a considerable size, and if left to itself will soon become difficult to destroy. This is one of the commonest weeds about the University grounds, and also throughout most of the State, being a serious pest in orchards and vineyards.

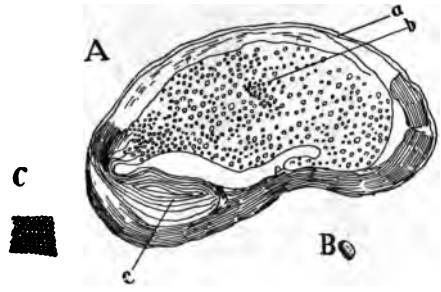


Seed of Malva parviflora.

A. One nutlet of fruit; greatly enlarged. *B.* Shape of nutlet and external markings. *C.* Seen in partial cross-section. *D.* Natural size.

LEGUMINOSÆ. (Pea Family.)

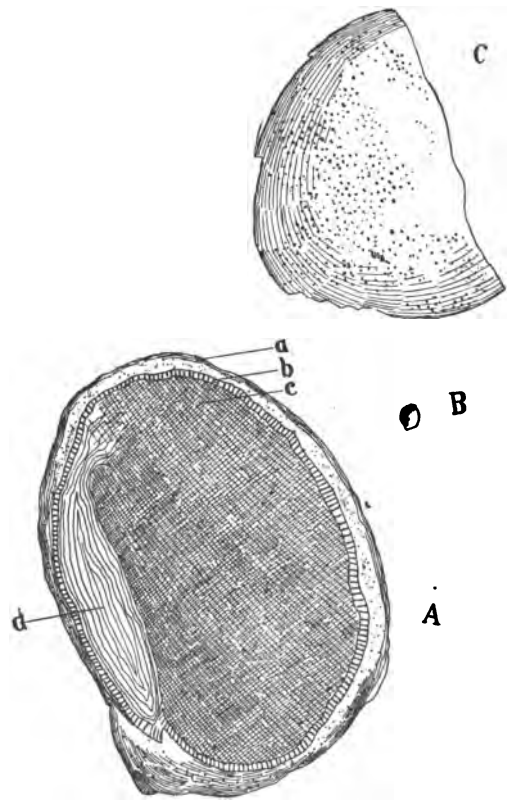
Medicago denticulata, or "Burr Clover."—This is in many places a valuable (dry-) forage plant, but at the University it is a troublesome weed.



Seed of Medicago denticulata.

A. Seed seen in section. *a.* Thin shell coat. *b.* Tail of embryo: granular. *c.* Head of embryo. *B.* Natural size. *C.* External markings; very minute; color light yellow.

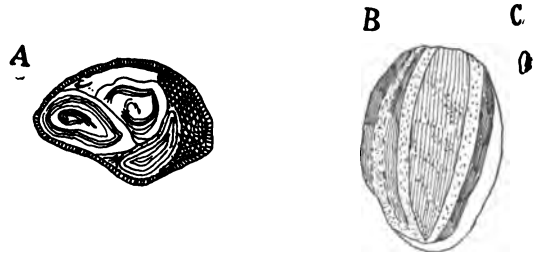
Lupinus micranthus.—This occurs in open fields and pastures, but is not at all troublesome, because of its slow growth; it is easily destroyed.



Seed of Lupinus micranthus.

A. Seed in section; showing embryo. *a.* Seed-covering. *b.* Section of covering. *c.* Granular substance. *d.* Head of embryo. *B.* Natural size. *C.* Portion of seed, showing external markings; black dots on a white shining surface.

Trifolium gracilentum.—One of the ordinary annual field clovers, and a very good pasture plant.



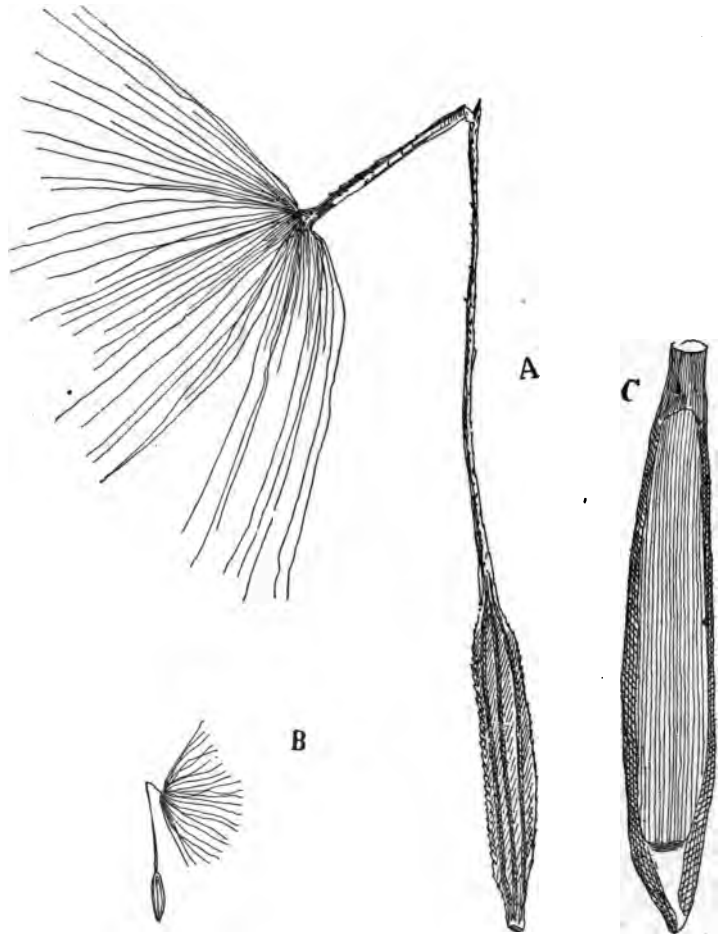
Seed of Trifolium gracilentum.

A. Shown in cross-section. *B.* Showing external markings. *C.* Natural size.

COMPOSITÆ. (Sunflower Family.)

Cichoriaceæ. (Chicory sub-family.)

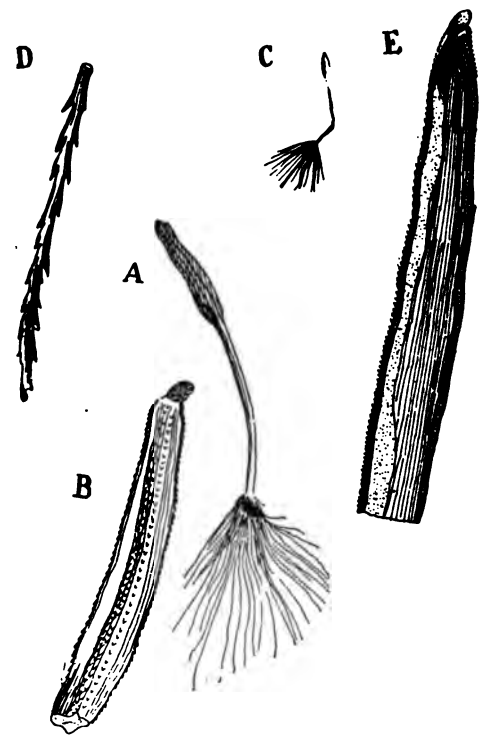
Agoseris plebeia.—Called by many "dandelion," but wrongfully, as it is of a different genus, the true dandelion being a *Taraxacum.* It is a perennial, from twelve to eighteen inches high, leaves all radical, large yellow heads borne on a long slender scape. It is found in open dry fields and pastures, with the clovers and other *Compositæ.* It is not very troublesome, as it can be easily killed by an ordinary hoeing; but it spreads rapidly in lawns and pastures.



Seed (akene) of Agoseris plebeia.

A. Greatly magnified to show appearance of akene. *B.* Natural size. *C.* Seen in section.

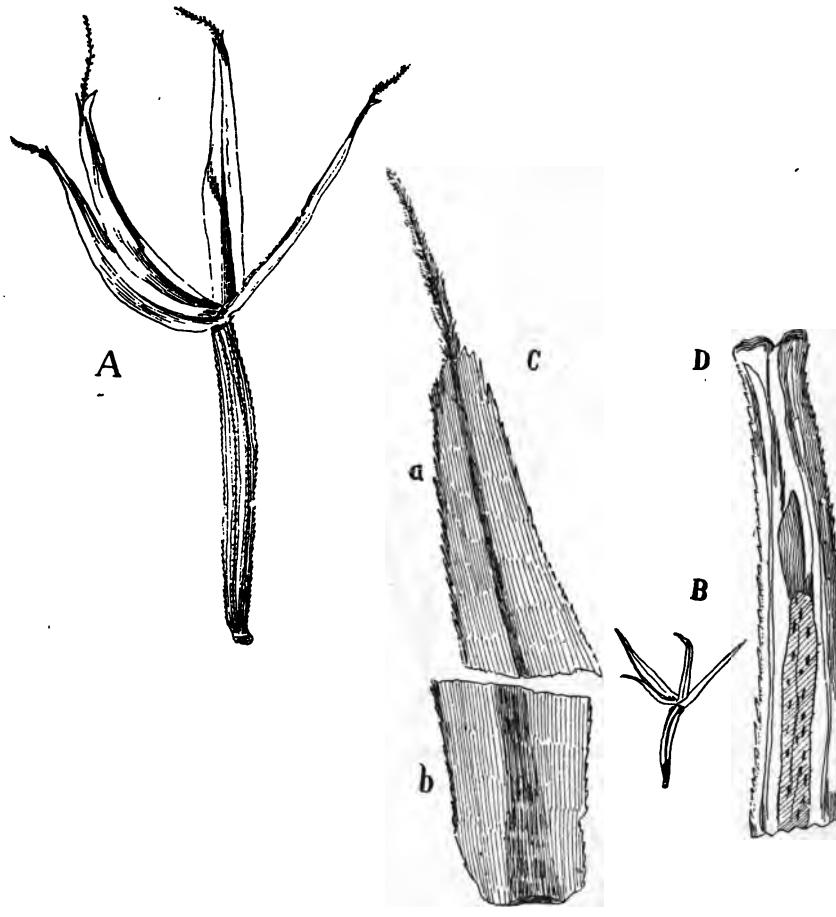
Agoseris hirsuta.—In appearance this is similar to the last, but somewhat smaller. It is a perennial found in dry, hard ground; it seems to do best in hot, dry places, especially on sunny slopes. It is easily eradicated individually, but a prolific seed-bearer, and, in consequence, a rapidly spreading weed. Like all *Cichoriaceæ*, its seeds are scattered far and wide by the wind; hence, it should be destroyed before it ripens its seeds.



Seed (akene) of Agoseris hirsuta.

A. Akene and pappus; enlarged. *B.* Portion of akene, showing markings and cross-section. *C.* Natural size; color dull straw; pappus white. *D.* Magnified view of one hair of pappus. *E.* One half of akene shown in section.

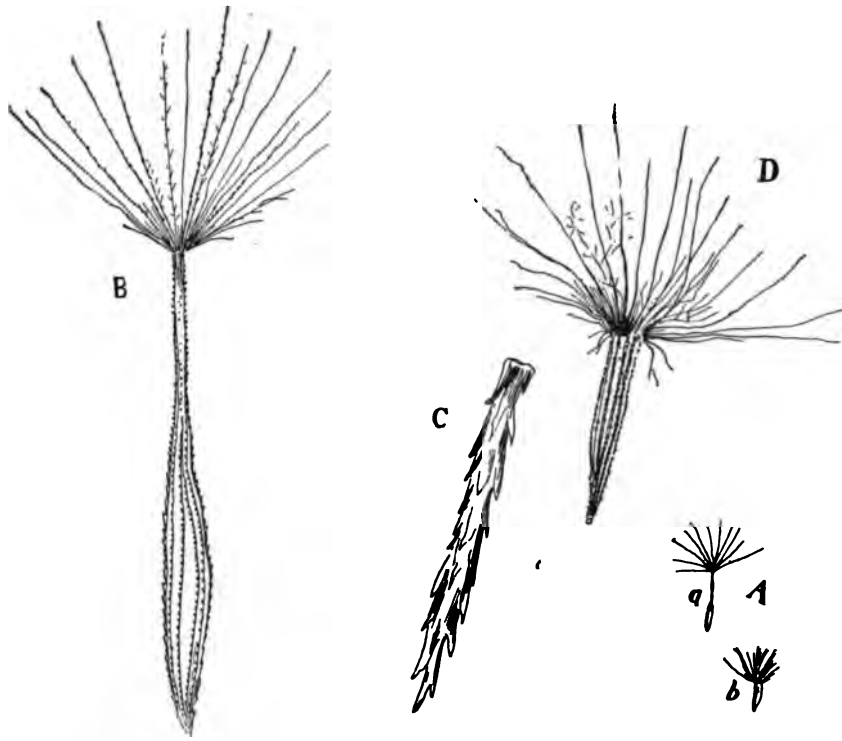
Calais Lindleyi.—This is a low annual, from four to eight inches in height, found along roadsides and other dry waste places. It is hardly a pest, as it cannot stand good cultivation. When once secure in a field it is, however, quite tenacious. It bears many seeds on a slender leafless scape.



Seed (akene) of Calais Lindleyi.

A. Showing minute markings of akene. *B.* Natural size. *C.* One scale of pappus. *a.* Tip. *b.* Base. *D.* In partial section; showing kernel, also in section.

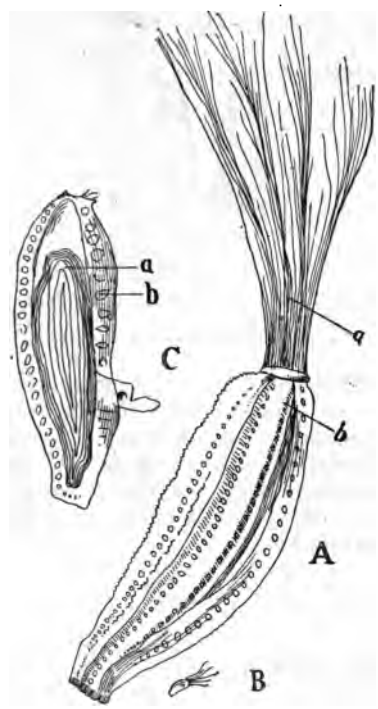
Hypochæris radicata.—A perennial, related to the dandelion, but the rosette of depressed leaves is hairy; the stem is almost leafless, branching and bearing a considerable number of scattered yellow dandelion-like flowers. In the University lawns this is a troublesome weed, but hardly rises to the dignity of a pest. It is also very common in Oakland lawns, where it seems to produce many crops of seeds in a season. As will be seen from the figure, two different forms of the fruit are found in the same flower-head.



Seed (akene) of Hypochæris radicata.

A. Natural size. *a*. Stipitate pappus. *b*. Sessile pappus. *B*. Showing stipitate pappus and external akene markings. *C*. Portion of one hair of pappus. *D*. Showing seed with pappus sessile on the summit of the akene.

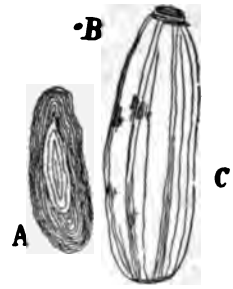
Sonchus oleraceus.—This is commonly called "sow thistle," and by some, on account of its white juice, "milk-weed." It is a ragged-looking annual, found mostly in waste ground and around rubbish, but also a persistent invader of cultivated fields and gardens. The stem is a large, angular, hollow column, quite fragile, and from two to three and one half feet in height. The large, wavy leaves are armed with weak spines. It is a very tenacious weed, but not specially troublesome, although a nuisance in pastures and about other uncultivated ground. It yields readily to the cultivator and hoe, but will sprout vigorously from any portion of the stem left connected with the root. It is eaten greedily by cattle and horses. It was introduced from Europe.



Seed of Sonchus oleraceus.

A. Akene with pappus; greatly magnified; color yellowish brown. *a.* Pappus. *b.* External markings. *B.* Akene with pappus; natural size. *C.* Form and position of kernel. *a.* Seed. *b.* Shell.

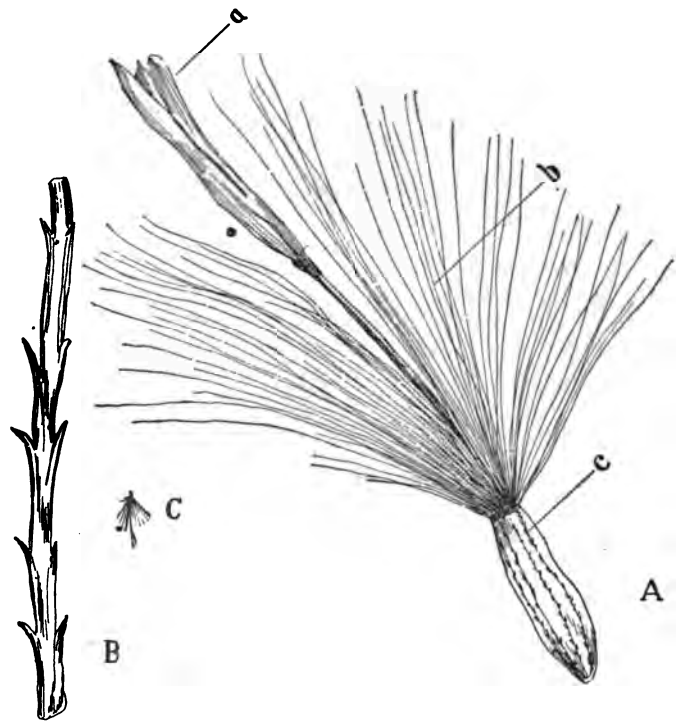
Matricaria discoidea.—This is a very disagreeable, troublesome annual weed, growing in masses six to eight inches high, with green ribs, yellow flower disks, devoid of ray-flowers, and finely divided leaves covering the stem; of a rather pleasant chamomile odor. It delights in the most unpromising situations, especially overgrowing the edges and unused parts of walks and roads, which places act as recruiting offices from which it branches out to interfere with everything. It is called by some "May-weed," but this is a mistake, as the commonly called May-weed is *Cotula.* Its seeds are so small as to be almost indistinguishable as such by the naked eye. Thorough cultivation will destroy it, but at the least cessation of care it resumes its attack. An interesting illustration of seeking favorable conditions is seen in the field south of the Experiment Station building. A path crossing the field is being slowly lined by this weed, which is pushing from each end towards the center. Throughout the field its size is small and growth feeble; at the path margins it is large and vigorous.



Seed (akene) of Matricaria discoidea.

A. Akene greatly enlarged. *B.* Natural size. *C.* Showing external markings.

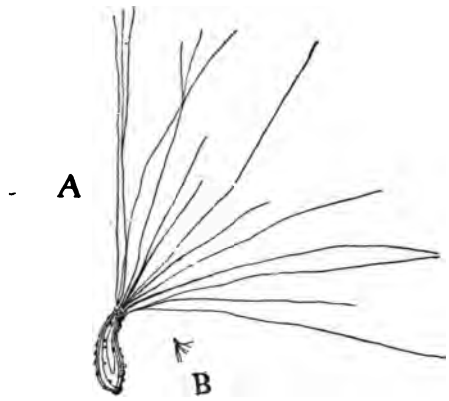
Senecio vulgaris.—This is a common weed found everywhere and producing seed almost the year round. It is a low, slender annual with soft, hollow stems and oblong leaves obtusely lobed almost to the midrib, with yellow cylindrical flower-heads. Its prolific growth renders it a bad pest—in gardens chiefly, because of its untidy appearance; but if unchecked by cultivation, it will choke out everything else, its seeds germinating in the driest season.



Seed (akene) of Senecio vulgaris.

A. Greatly magnified. *a.* Old corolla. *b.* Pappus. *c.* Seed. *B.* One hair of pappus. *C.* Natural size.

Gnaphalium purpureum (Purplish Everlasting).—This is a slender, soft, hairy annual, from twelve to eighteen inches in height; it is especially troublesome in pastures, but in fields it yields readily to ordinary cultivation.

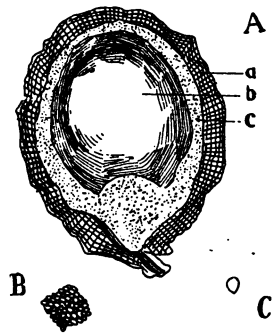


Seed (akene) of Gnaphalium purpureum.

A. Greatly magnified. *B.* Natural size.

LABIATÆ. (Mint Family.)

Stachys bullata.—This is a pretty little plant, with pink-colored, two-lipped flowers, opposite leaves, emitting a strong unpleasant odor when crushed. It is found in moist places in cultivated fields and orchards. It is not seriously troublesome.

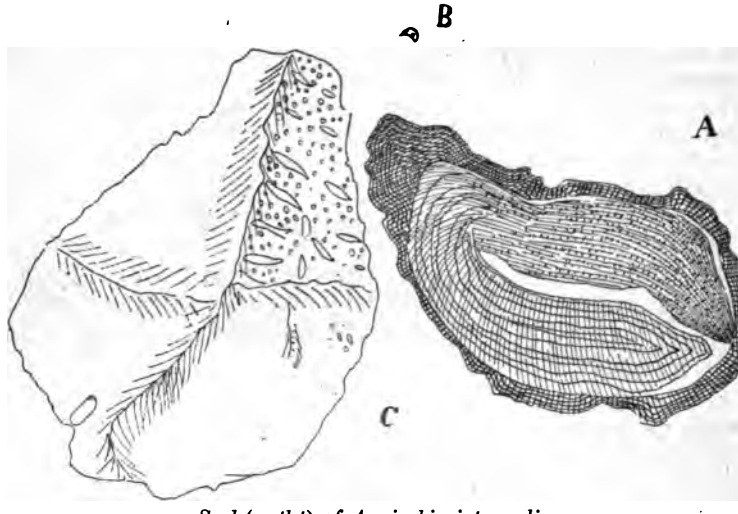


Nutlet of Stachys bullata.

A. Seen in section across middle of nutlet. *a.* Seed shell. *b.* Albuminoid matter. *c.* embryo. *B.* External markings of nutlet; color dull brown. *C.* Natural size.

BORRAGINACEÆ. (Borrage Family.)

Amsinckia.—This genus, although a close relative of the "forget-me-not," furnishes the farmer one of the most formidable weed pests. It will completely ruin a grain field if unchecked; in fact, if it gets a start in a growing wheat field, there seems to be no known remedy for the season. The best thing to do is to take care that it is not introduced by means of its seed being mixed with the seed-grain; this can easily happen, because the Amsinckia seed is small enough to escape detection unless specially sought for. The specimen shown in the drawing is that of *A. intermedia*, which is not, however, the worst pest. *A. lycopsoides* is the one that most commonly infests wheat fields, and is the most troublesome and dangerous. But good cultivation will destroy either, as they are annuals; only it will be necessary to omit at least grain crops for one or two years, and carefully prevent any from going to seed.



Seed (nutlet) of Amsinckia intermedia.

A. Seen in cross-section. *B.* Natural size. *C.* Shape and external markings.

The Amsinckias are often called "yellow tar-weed," although they are innocent of any tarry matter, but adhere by their hooked bristles. "Yellow forget-me-not" would describe the plant very well.

REPORT ON TREES PLANTED ON MOUNT HAMILTON.

By K. McLennan.

In accordance with the instructions of the Director, I left Berkeley early in August, 1890, and proceeded directly to Mount Hamilton. After reporting to Prof. E. S. Holden, I spent several days in determining where it was best to begin and what varieties were best suited to different exposures. We first commenced to replace the dead trees, of the planting of the spring of 1889, along both sides of the main avenue leading from the astronomers' cottages and around Professor Holden's house. Here we used the following varieties of trees: *Libocedrus decurrens, Thuja gigantea, Pinus austriaca, Pinus Sylvestris, Cupressus Lawsoniana.* These were sent from the University propagating houses. We also planted the following named varieties, obtained from the California Nursery Company: *Picea nobilis, Picea concolor, Abies excelsa.* A number of *Sequoia sempervirens* were scattered here and there in the rows. On the bank above Professor Holden's house and in front of the workshop we planted *Juniperus Sabina*, obtained at the University. Several *Sequoia sempervirens* (redwood) were set in front of each of the cottages.

On the east side of the mountain, forty-five feet below the main road going up from the astronomers' cottages to the Observatory, and starting from the first cottage, we planted an avenue around the mountain to the north as far as the rocks would permit. This avenue was planted with redwood trees eighteen inches high, all balled and in good condition. We also planted on the east side, again around to the north, using groups of all the species named. Between the laborers' cottages and those of the astronomers, we planted Picholine olives and trees of the *Arbutus unedo*, all sent from the University grounds.

Observations made on trees planted in 1889 show that the *Cedrus deodara, Libocedrus decurrens* and *Mahonia aquifolia* were all living and doing excellently. *Sequoia gigantea* (Big Tree), *Cupressus macrocarpa* (Monterey cypress), *Pinus muricata*, and *Pinus insignis* (Monterey pine) suffered somewhat; some of them were entirely gone. *Picea concolor* and *Picea excelsa* were doing fairly well, as were also some almond trees that were planted at Professor Holden's house. All the other orchard trees that were then planted have perished, and the survival of the almonds is a very curious fact.

The total coniferous tree planting of this year consisted of one hundred *Redwoods*, fifty *Picea nobilis*, fifty *Picea concolor*, fifty *Abies excelsa*, sixty *Libocedrus decurrens*, and fifty *Cupressus Lawsoniana.* There are plants of *Abies Douglassii, A. Menziesii, Pinus ponderosa, Picea magnifica*, and other Pacific Coast trees now being grown in the University propagating houses for future use on Mount Hamilton.

B. THE FOOTHILL STATION.

Five miles north-northeast from Jackson, Amador County.

By CHARLES H. SHINN.

The Foothill Station, near Jackson, Amador County, is attracting more attention than formerly, the number of visitors increasing, and the interest of the community in the work done there being more manifest. Since the last report was issued, several permanent improvements have been made. A large tank has been built on the hilltop near the house, and the reservoir planned for on the southern hill has been completed. It was cut in the rock, and cemented inside; another coat of cement was applied in August, to render it secure, and siphon pipes put in, so as to use the water on the orchard below. The pump in the mining ditch continues to work excellently, except that the grit in the water wears out couplings rapidly. A good deal of grading has been done on the land, new roads cut, new gates put in, the bridge near the station rebuilt, and in all respects the development of the farm continued as much as was possible with the amount of labor at the Foreman's diposal. The soil requires constant care, to prevent "washing out" during winter, or when irrigating, and dangerous places are gradually being protected by walls of rock. Glass for a propagating house, in which seeds and cuttings can be started, and plants that have suffered during shipment can be restored to health, has been sent to the station.

Notes upon some experiments with fertilizers at the station will be found elsewhere in this report.

THE ORCHARD.

During the planting season of 1890–91, the orchard was increased by such varieties as are at the other stations, but were unrepresented here. All the gaps left by failure to grow were replanted. The actual extensions thus made were slight. There is room for additional orchard, but another season is necessary to secure abundant stock of new varieties.

No *Apples* were sent from the Central Station, owing to the presence of woolly aphis on the stocks grown too closely on long-cultivated soil. The apples and other trees sent were carefully inspected and disinfected thoroughly so as to destroy all scale or other insect pests. Twenty-five apple trees were planted at the Foothill Station; three—Clotie, Early Ripe, and Stump—were new to this district. The apples already planted show fair growth, and promise better on the red soil than on the decomposed granite soil, which will probably need to be fertilized if heavy crops are to be obtained.

Pears show a decided gain in growth over the season of 1889, and particularly so in the case of the Japanese seedlings, some of which will be budded this year. Five or six of these Japanese seedlings show marked characteristics, freedom from thorns and clean appearance; they

will be allowed to fruit. Only thirteen pear trees were required to fill the gaps.

Plums and *Prunes* are much the same as at the other stations. Peach, apricot, and Myrobalan are the stocks. Dormant buds, many of which failed, have been replanted. All the plums and prunes grow slowly, but the foliage is darker than in the valleys, and the growth is more stocky. Several new plums were planted this season. The Japanese varieties have fruited this year (1891), as at some other stations. It seems evident, that in the dwarf early Japan plums, and in seedlings and hybrids from them, the *true garden plum* for the millions has been discovered. Trees, that by measurement are less than thirty inches high, are loaded with fruit of excellent quality at three years of age (one-year trees, two years planted in orchard).

The *Apricots* have grown rather better on plum stock than on apricot, but it is too early yet to determine the relative values of these stocks for this soil. Among the new varieties are the Newcastle, and several other California seedlings.

Peaches and *Nectarines* are much the same in growth. Among the new peaches planted this season are Elberta, Noblesse, Bonanza, and Newhall. Twenty trees were sufficient to fill the gaps caused by loss of dormant buds. The gum disease noted in 1889 on the peach and nectarine roots has lessened, as the season of 1890 was more dry, and greater care was taken not to over-irrigate. Few of the trees received any water at all. The health, vigor, and beauty of most of the peach trees, particularly on the red soil, is very gratifying. Some fruit will be gathered this year; in fact, it has proved necessary to "thin out" some of the trees that were carrying too much.

Almonds continue to make rapid growth. This tree thrives, however, in many places where frosts prevent the fruit from "setting," and hardiness is the most important point to be considered. The list of varieties planted is now so complete that we only need to add new seedlings of promise as fast as they appear in different parts of California. As fast as varieties are proved too tender, or otherwise ill-adapted to the region, they can be "worked over," so as to test other sorts.

Cherries have been a surprise. Only six failed in the orchard, and have been replaced. The growth of the trees was most excellent. They are on the stronger (red) soil, and well sheltered. It is too soon to determine whether or not they have the strong tendency to gum disease and cracking of the bark that renders the cherry an uncertain crop in so many places in the foothills. At present there is no sign of this trouble. Some of the largest cherry trees in the State are on farms of the Sierra foothills; but only a few districts, such as Newcastle, can show much cherry planting on a commercial scale. With the steady increase in demand for the finer cherries, a larger area of red foothill lands could be profitably employed in cherry culture.

Figs continue to grow well, and many cuttings have been rooted at the station. The fig avenues have been extended completely around the reservoir hill, and the fig will be used in many other places for ornament and utility. The "Bulletin" Smyrnas are among the strongest growers. Rocardi, Ronde Noir, and Negro Largo are, among the new varieties, particularly good trees. All, without exception, are evidently at home on all the soils of the station.

The *Olives*, so well represented here, attract more attention from vis-

itors than any other culture. The entire avenue is complete. The granite soil shows excellent growth, and the red soil shows still better. All parts of the station farm are adapted to the olive. Among the best, and showing some blossoms this year, are Rubra and Uvaria. Nevadillo blanco is the strongest grower. Manzanillo and Oblonga are also especially attractive. There will be a demand among the Italian settlers in Amador County for all the olive stock that the station can possibly spare. The fig, grape, and olive are the three cultures that seem to appeal most forcibly to the land owners in the immediate district.

Among the nut-bearing trees the *Walnuts* make the best appearance. *Pecans* come next, and ripen foliage early, so that the fruit will probably mature at the proper season. In the San José Valley the pecan does poorly in this respect, the nut seldom falling till late in spring. The *Chestnuts* grow poorly at the Foothill Station, though the Italian and Japanese promise better than the American.

REPORT ON THE GROWING OF GRAINS IN 1890 AND 1891 AT THE FOOTHILL STATION.

By GEORGE HANSEN.

Below we give lists of all those varieties of grains which have been sown in trial beds of different sizes all over the station ground, provided they were not in the way, and allowed of easy inspection. They are self-explanatory in the main, showing first, the different heights of the grains on our two chief soils, under different conditions of sowing and rainfall; marking those which were worthy of special notice, whether good or poor. Thus far it is difficult to say whether one or the other variety is best adapted to this or that soil—nearly as hard as it is to tell of what character the rainy season is likely to be. The object in sowing and resowing our grain for so many consecutive years, is to find out how the several kinds prosper, under the various conditions of weather or season, on the several soils at our command. For instance:

The sowing of 1890 took place in the time from February 2d to March 1st. The winter had been unusually wet, almost too wet to do any work, there having fallen at the station nearly sixty inches of rain, and as many of snow. In spite of the late season, the grains were sown just to see how they would turn out. That year they received, during their time of growth, a rainfall of 17.57 inches and 15.7 inches of snow, divided as follows: February, 4.43 inches of rain and 15.7 of snow; March, 8.18 inches of rain; April, 2.49 inches of rain; May, 2.47 inches of rain. The last rain came May 11th, and to secure any success we had to hoe the beds to loosen the ground and to prevent the soil from drying out in the hot time following. July 31st, we gathered the last ripe seed.

The season of 1891 was more favorable, though the grains (on account of pressure in the bust season) were not sown till January 15th. The rainfall amounted to 19.45 inches, divided over the months: January, none; February, 6.55 inches; March, 6.36; April, 4.09; May, 1.18; June, 1.27; the last rain, of 1.27 inches, coming down June 12th. The last rain, damaging as it was to the hay crop, was the making of our grain trials, as it was for seed-growing generally. If we had had such a late rain the year before no hoeing would have been needed.

The wonderful difference in results caused by the different seasons is easily seen by comparing the columns. I did not comment on the quality of the grain grown in 1890, because all were put in so late that perhaps but few farmers in our foothills would think of sowing at all if they could not have found time earlier in the year. Still, there were quite a number who did risk the outlay in seed (barley could hardly be purchased for $42 up here), hoping for late rains. Some were successful; others would not trouble with mowing such low stalks as they found on their fields, and turned their stock on them. For these, our experiment of 1890 is of value, for they can find, in the tables, quite a number of varieties that would have proved worthy of reaping, in spite of the advanced season.

In regard to the different soils, I must say that though we have the red and the granite soils of the foothills represented, and always speak about them as the two chief varieties, there are really many more soils on our grounds. For instance, the granite soil is, in part (on the lower ground), so exceedingly poor, that on a field of wheat sown where we had quite a number of little grain-beds last year, one could have marked, within a couple of inches, the walks and borders of the bed by the difference in the color of the grain—it looked somewhat like a chess board. The granite soil on which the grain was sown this year lies on a low slope, and is comparatively rich, from an admixture of wash from the red soil. As a striking example, I mention Nepaul barley, which, the year before, attained a height of but twenty-four inches, this year grew forty-one inches high; the same can be said of portions of the red soil. We have spots too sandy to be adhesive, even if wet, and too stiff to break up when dry, rich enough to grow Surprise oats five feet high in a poor season, and too poor to allow Red Emmer wheat to grow higher than twenty-seven inches, whereas, in fairly good granite soil it grew forty-seven inches.

Our experiments are, of course, quite incomplete as yet; they will be carried on further, and the lists extended and completed by the results obtained through earlier sowing and different seasons.

WHEATS.

Variety.	Year.	Average Height.		Seed Ripe.		Remarks.
		Red Soil.	Granite Soil.	Red Soil.	Granite Soil.	
Archer's Prolific	1890	30 in.		July 23		
	1891		43 in.		July 4	Good heads.
Arizona Indian Seed	1890	30 in.		July 24		
	1891		42 in.		July 6	Good heads.
Black Centennial	1890	55 in.		July 22		
	1891		58 in.		July 21	Very good.
Blue Glass	1890	33 in.		July 23		
	1891		40 in.		July 8	
California Spring	1890	34 in.		July 23		
	1891		39 in.		July 10	Good.
Champlain	1890	39 in.		July 23		
	1891		48 in.		July 4	
Clawson	1890	42 in.		July 23		
	1891		49 in.		July 10	Good.
Defiance	1890	36 in.		July 23		
Diamond (Polish)	1890	52 in.		July 23		
	1891		50 in.		July 20	Good.
Egyptian	1890	50 in.		July 21		
	1891				July 14	Good.
Fern (April)	1890	46 in.		July 23		

WHEATS—Continued.

Variety.	Year.	Average Height.		Seed Ripe.		Remarks.
		Red Soil.	Granite Soil.	Red Soil.	Granite Soil.	
Forelle	1890	39 in.		July 23		
	1891		41 in.		July 15	Poor.
Frankenstein	1890	37 in.		July 23		
	1891		48 in.		July 19	Good.
Genoese	1890	35 in.		July 23		
	1891		46 in.		July 9	
Ghurka (Odessa)	1890	38 in.		July 23		
	1891		43 in.		July 4	
Greek Atlanti	1890		39 in.		July 31	
	1891		45 in.		July 4	Good.
White Victoria (Hallett's pedigree)	1890		35 in.		July 31	
	1891		11 in.		July 22	
Harris from Jasper	1890	34 in.		July 23		
	1891		43 in.		July 4	Poor.
Hungarian (Brenner)	1890	32 in.		July 23		
	1891		47 in.		July 4	Good.
Hungarian (Burke)	1890	30 in.		July 24		
	1891		43 in.		July 16	Good.
Improved Circassian	1890	37 in.		July 24		
	1891		48 in.		July 6	Poor.
Indian (three months)	1890	37 in.		July 24		
	1891		44 in.		July 12	Poor.
Indian (winter)	1890	37 in.		July 24		
	1891		42 in.		July 10	Poor.
Missoyen	1890		40 in.		July 31	
	1891		46 in.		July 6	Very good.
Nicaragua (E. K. Carr)	1890	50 in.		July 23		
	1891		52 in.		July 12	Very good.
Nonette Lousanne	1890	40 in.		July 24		
	1891		45 in.		July 12	Good.
Nonpareil	1890	36 in.		July 28		
	1891		45 in.		July 10	Good.
Oregon Big White Club	1890	36 in.		July 28		
	1891		45 in.		July 6	Very good.
Palestine	1890		21 in.		July 31	Very poor.
	1891		32 in.		July 6	Good heads.
Petali	1890		30 in.		July 31	Very poor.
	1891		41 in.		July 8	
Pringle's Best	1890	37 in.		July 25		
	1891		42 in.		July 23	
Pringle's Defiance	1890	39 in.		July 25		
	1891		39 in.		July 5	
Proponti	1890	34 in.		July 25		
Red Club (Hedgehog)	1890	36 in.		July 25		
	1891		47 in.		July 4	Very good.
Royal Australian	1890	36 in.		July 28		
	1891		51 in.		July 6	Good.
Russian Red-Bearded	1890	34 in.	35 in.	July 28	July 31	Gr'it e a failure.
	1891		44 in.		July 4	
Snowflake	1890	37 in.		July 25		
	1891		48 in.		July 12	Very good.
Taganrog	1890	48 in.		July 25		
	1891		48 in.		July 6	Heavy heads.
Thuringian	1890	37 in.		July 25		
	1891		48 in.		July 21	Very good.
Tonzelle	1890	31 in.		July 25		
	1891		43 in.		July 23	Very good.
Tunisian	1890	49 in.		July 25		
	1891		50 in.		July 23	Poor heads.
Victoria	1890	34 in.		July 31		
	1891		41 in.		July 19	
Volo	1890	33 in.		July 26		
	1891		46 in.		July 21	Poor.
Whittington	1890	32 in.		July 25		
	1891		51 in.		July 8	Good.
Yellow Noé	1890	39 in.		July 26		
	1891		48 in.		July 6	Good.

The varieties of wheat sown in 1890 were sown also in soil consisting of a mixture of red and granite soils; the difference in the height of the grain was not worth recording.

BARLEYS.

Variety.	Year.	Average Height.		Seed Ripe.		Remarks.
		Red Soil.	Granite Soil.	Red Soil.	Granite Soil.	
Berkeley Hybrid	1890		26 in.			
	1891		30 in.		July 3	
Black, six-rowed	1890		30 in.		July 8	
	1891		40 in.		July 2	
Bluish	1890		27 in.			
Carter's Prolific	1890		30 in.		July 8	
	1891		37 in.		June 30	
Chevalier	1890		30 in.		July 7	
	1891		36 in.		June 30	
Early Black, six-rowed	1890		36 in.		July 7	
	1891		35 in.		June 27	
Himalaya	1890		30 in.		June 26	
Hallett's pedigree of Chevalier	1890		30 in.		July 14	
	1891		36 in.		July 2	
Imperial	1890		32 in.		July 14	
	1891		40 in.		June 30	
Italian	1890		36 in.		July 7	
	1891		40 in.		June 30	
Kalina	1890		32 in.		July 9	
	1891		43 in.		July 5	Good.
Large Naked, two-rowed	1890		27 in.		July 19	
	1891		39 in.		July 2	Poor.
Mandchurian	1890		34 in.		June 30	
	1891		30 in.		June 29	
Nepaul	1890		24 in.		July 19	
	1891		41 in.		July 24	Good.
Rice	1890		32 in.		July 23	
	1891		37 in.		July 25	
Scotch, two-rowed	1890		26 in.		June 30	
	1891		32 in.		July 2	
Six-rowed (Brenner)	1890		29 in.		July 19	
	1891		32 in.		July 2	Good.
Small Blue Naked	1890		30 in.		July 19	
	1891		37 in.		July 2	
Six-rowed Winter	1891		34 in.		June 26	

OATS.

Variety.	Year.	Average Height.		Seed Ripe.		Remarks.
		Red Soil.	Granite Soil.	Red Soil.	Granite Soil.	
Bald	1890	32 in.	33 in.	July 12	July 19	
	1891		46 in.		July 7	
Black Tartarian	1890	42 in.	35 in.	July 12	July 31	
	1891		45 in.		July 10	
Canadian	1890	52 in.	37 in.	July 8	July 14	
	1891		56 in.		July 5	
Early August	1890	42 in.	31 in.	July 14	July 14	Very good.
	1891		50 in.		July 12	
From E. K. Carr, Texas	1890	28 in.	26 in.	July 8	July 15	
	1891		36 in.		July 10	
Early, from Caulomers	1890		27 in.		July 16	
Early, from Georgia	1890	38 in.	31 in.	July 14	July 14	
	1891		40 in.		July 14	
Gray oats from Houdan	1890	49 in.	43 in.	July 14	July 31	
Large Naked	1890	42 in.	30 in.	July 8	July 19	
	1891		42 in.		July 12	
Scotch Hopetown	1890	48 in.	42 in.	July 8	July 15	
	1891		52 in.		July 7	
Surprise	1890	51 in.	47 in.	July 8	July 17	
	1891		60 in.		July 15	Very good.
White Bolognese	1890	46 in.	45 in.	July 21	July 31	
	1891		55 in.		July 8	Very good.

RYES.

Variety.	Year.	Average Height.		Seed Ripe.		Remarks.
		Red Soil.	Granite Soil.	Red Soil.	Granite Soil.	
Excelsior	1890	49 in.	49 in.	July 28	July 30	
	1891		59 in.		July 5	
Perennial Saxon	1890	50 in.	45 in.	July 28	July 30	
	1891		62 in.		July 4	
Spanish Double-bearing	1890	42 in.	38 in.	July 28	July 30	
	1891		64 in.		July 10	Very good.
St. John's Day	1890	47 in.	43 in.	July 28	July 30	
	1891		68 in.		July 2	Good.
Swedish Sand	1890	43 in.		July 30	July 30	

The rye on granite soil sown in 1890 showed poor heads.

SPELTS.

Variety.	Year.	Average Height.		Seed Ripe.		Remarks.
		Red Soil.	Granite Soil.	Red Soil.	Granite Soil.	
Blue-Bearded	1890	34 in.	-------	July 26	July 30	-------
	1891	-------	48 in.	-------	July 23	---Very good.
Common White-Bearded	1890	29 in.	-------	July 26	July 30	------- -------
	1891	-------	47 in.	-------	July 6	-------
Red Emmer	1890	30 in.	-------	July 27	July 30	-------
	1890	30 in.	-------	July 27	July 30	---Very good.
White Emmer	1890	30 in.	-------	July 27	July 30	-------
	1891	-------	47 in.	-------	July 12	-------
White Silesian	1890	34 in.	-------	July 29	July 29	-------
	1891	-------	46 in.	-------	July 20	-------

The red soil on which the spelts were sown in 1890 was of the most rocky kind imaginable.

FERTILIZER EXPERIMENTS AT THE FOOTHILL STATION.

The very small product of hay per acre realized on many of the foothill soils, notably on those of the granitic character, and directly the heavy expense annually incurred by the station in the purchase of its hay supply, rendered it desirable to try the effect of various fertilizers in increasing the crop. Some of the level land of the tract lying north of the Amador ditch, and of the purely granitic type, was used for this purpose; unfortunately it had just been cleared of a growth of chaparral and small oak, and the uneven condition rendered it difficult to apportion the experimental plots as might have been desired; hence it was thought best to use rather excessive amounts of fertilizers. The results of the season may therefore be considered as suffering with some uncertainties, yet the results, as hereinafter reported by Foreman Hansen, are sufficiently indicative of the direction in which increase of production is to be sought. The analysis of the soil had indicated that, while potash is abundant (as it is in most California soils), this granitic soil is very poor in phosphates and in humus, hence, inferentially in nitrogen. Hence, the fertilizers chosen for this first trial were bone dust and nitrate of soda; also, a prepared fertilizer supplied by the "Mexican Phosphate and Sulphur Company" of San Francisco. The brand "C" of that manufacture is reported to be composed as follows:

Phosphoric acid.....12 per cent.
Potash.....5 to 6 per cent.
Ammonia.....3 to 4 per cent.

Mr. Hansen's report is as follows:

REPORT ON THE EXPERIMENTS IN HAY-GROWING WITH THE AID OF DIFFERENT FERTILIZERS AT THE FOOTHILL STATION.

By GEORGE HANSEN.

The *McKay tract*, comprising about six and one half acres, lying at the north end of the station grounds, has been cleared. The Amador Canal lies on one side, and it and the debris of a cut in granite of an average depth of about twenty feet take up about two acres of it. Of

the rest of the tract, two acres were put into condition to grow a crop of hay, partly in order to reduce the heavy outlay for hay required for the team (hay delivered averages $20 per ton), partly to experiment in hay-growing with the aid of fertilizers.

The clearing of the ground proved a rather heavy expense, costing fully $50 per acre on account of the numerous small oaks which had to be grubbed out. Only two acres could be got ready this season for experimenting. They are in the west half, in the shape of a parallelogram, the sides four hundred and forty and two hundred feet respectively, but deducting some rocky spots and the bends of the ditch, we could not make use of more than one and four fifths acres. We laid it out in parallel strips, which could not be given an equal area, as we had to have as much under cultivation as we possibly could get. But the areas were measured so exactly that a comparison is very easily made. The plots contained: No. I, 21,120 square feet; No. II, 18,720 square feet; No. III (divided in halves—*a* and *b*), 9,120 square feet each; and No. IV, 18,240 square feet.

The *soil* of the tract is, in the main, a decomposed granite, a trifle better in the eastern part. In the northwest corner our red foothill soil adjoins, extending to a line beginning twenty-five feet from the corner, cutting crossways towards the ditch, a line two hundred and fifty feet long, making the base of the cut-off three-cornered piece one hundred and ninety feet. This part, of the red soil, is of a clayey nature, lacking sand until it intermixes with the granite. The tract slopes gently towards the south.

The ground was plowed the regular way, and in good condition when we sowed the *fertilizer* and seed, as follows: No. I, 225 pounds of nitrate of soda; No. II, 400 pounds of bone dust; No. III*a*, without fertilizer; No. III*b*, brand "C" of Mexican Phosphate and Sulphur Company of San Francisco; No. IV, 100 pounds of bone-meal and 100 pounds of nitrate of soda.

The *seed*, four hundred and forty-five pounds of valley-grown barley, was sown immediately after plowing and the distribution of the fertilizers, on January 29th. Considering the poorness of the ground, it must be called a rather thin sowing.

The *rainfall* the grain received during its growth was 18.18 inches, thus distributed: February, 6.55 inches; March, 6.36 inches; April, 4.09 inches, and in May, 1.18 inches.

The *cutting* of the grain took place June 3d; the hay was wetted by a quite unlooked-for rain of 1.27 inches, on June 12th. This, of course, influenced the weight of the hay considerably, as it had to remain exposed to the weather for some time. The quality was little injured, as the succeeding wind and sun cured the hay.

The *weighing* of the crop gave four thousand two hundred and fifteen pounds as the total weight. The single lots turned out as follows: No. I, 943 pounds, or an average of 2,000 pounds per acre; No. II, 1,053 pounds, or 2,500 pounds per acre; No. III*a*, 334 pounds, or 1,500 pounds per acre; No. III*b*, 558 pounds, or 2,750 pounds per acre; No. IV, 1,327 pounds, or 3,000 pounds per acre.

In discussing these results it has to be taken into consideration that the hay was very unclean indeed; as cannot be otherwise expected on a piece of ground taken into cultivation for the first time, and right after clearing. The roots of the brake-fern (*Pteris aquilina*) pulled out while cutting

and the rake took them along; little roots, sticks and branches, also, got mixed in with the hay. I believe that if only the clean hay could have been weighed five hundred pounds would be lacking on the total as stated above. But this difference would have been of little importance if the grain had been sown earlier than was the case, and hence our figures, given with such exactness, might just as well be taken as a guiding result for any one who has to deal with similar conditions.

Table of Results.

Plot.	Area—Square Feet.	Fertilizers Used.	Weight of Hay Crop—Pounds.	Calculated Crop per Acre—Pounds.
No. I	21,120	225 lbs. of nitrate soda	943	2,000
No. II	18,720	400 lbs. of bone-meal	1,053	2,500
No. IIIa	9,120	No manure	334	1,500
No. IIIb	9,120	125 lbs. of "C" fertilizer	558	2,750
No. IV	18,240	{100 lbs. of bone-meal {100 lbs. of nitrate soda	1,327	3,000
Totals	76,320		4,215	

Memorandum of the above Table by E. W. H.

As regards, first, the check plot No. III*a* (unmanured), it should be stated that its low product—three fourths of a ton—is quite in accordance with the reports of the neighbors in cultivating such land. More than a ton per acre is rarely harvested.

It will next be noted that the addition of a somewhat excessive dose of nitrate (given to provide against the chance of washing out by rains) increased the crop only from three fourths to one ton per acre.

The bone-meal, slow-acting, but supplying both nitrogen and phosphoric acid, increased the product still further by five hundred pounds.

The nitrogenous superphosphate of brand "C," acting more quickly, although used in much smaller quantity, increased the product still further by two hundred and fifty pounds, being one thousand two hundred and fifty pounds more than the product of the unmanured plot.

Finally, a mixture of two hundred pounds of bone-meal with an equal amount of Chile saltpeter, yielded the maximum result of three thousand pounds, or double that of the unmanured plot. No. IV, however, had the advantage of a larger proportion of red soil.

It may be regretted that a check experiment with potash fertilizer was not made at the same time. This will, of course, be done the coming season, when the same, and some additional plots, will be again tested, with due regard for what the previous year's fertilization may have left in the soil.

The fact, however, that the joint application of phosphatic and nitrogenous fertilizers at once doubled the product of this soil, agrees perfectly with the indications furnished by the chemical analysis; and it is plain enough that when hay sells at $20 a ton, the use of the combination used in plot No. IV, costing (when using the perhaps excessive dressing here employed) about $7, will more than pay for itself. With heavier seeding and land in better condition, it would doubtless do a great deal more.

The question of the *least amount* of these and other fertilizers producing a profitable result, will form the subject of further trials.

C. SOUTHERN COAST RANGE STATION.

Two miles north-northeast from Paso Robles, San Luis Obispo County.

By CHARLES H. SHINN.

The station near Paso Robles, on the high ground east of the Salinas River, has been described in the previous report (of 1889). The tract is in the shape of a parallelogram, one thousand seven hundred and twenty feet in depth, and four hundred and twenty feet in width; the latter representing the frontage on the highway. The especial soil advantages of the tract become more evident every year, and although there is more frost than was expected, the range of culture is very extensive. The greater part of the tract is comparatively level, but there is a swale across it, and several lesser depressions, while the land rises towards the rear of the tract. The highest point is where the station buildings are situated.

Fine specimens of the native oaks remain, particularly near the buildings, but it was found necessary to remove seven others in 1890, because they took up too much ground in the orchard and vineyard. Those that remain are typical trees, and should be retained as long as possible. Owing to the nearness of the station to a noted summer resort, Paso Robles, and to the excellence of the country roads, it receives many visitors from all parts of the State.

Several important improvements have been made since the last report. A windmill now takes the place of the horse-power formerly used to raise water, and, contrary to the general opinion, is ample for the present needs of the station, though the horse-power can be used in case of long-continued calms. The worst part of the swale land has been drained, and made fit for orchard or small cultures.

The trees and vines are many of them beginning to bear fruit, and the culture-plots of grains, grasses, clovers, and other crops have attracted much attention. The Foreman, Mr. Cruickshank, is in demand every autumn at the District Fairs of Santa Barbara, San Luis Obispo, and other counties, to which he has taken a large collection of cereals and other station growths. His expenses have been paid from the funds of the respective fairs, and he has thus been able to meet the representative farmers of the entire region. He has not only distributed seed, but, in many cases, he has received valuable seeds and plants for the station. From farmers at Arroyo Grande he secured seventeen varieties of potatoes grown there, some of them seedlings; a new and promising pea from the Azores came through some Portuguese families in Santa Barbara County. The season for the District Fairs comes at a time when the Foreman can easily take a few days from his work, and there is hardly any other way in which the practical results of the experiment station can be brought so directly before the farmers.

THE ORCHARD.

Proceeding to a more particular account of the station, the orchard claims first attention. At my first visit, in the latter part of 1890, I was much pleased with the appearance of the apples, pears, peaches, and almonds; the apricots were some of them on unsuitable soil, in the adobe of the swale across the tract; some of the figs were where the frost appeared to nip them twice a year. The general aspect of the orchard, considering its youth and the variety of soils dealt with, was far better than one had reason to expect.

Apples will be of great commercial value in these Coast Range districts, but will probably prove better keepers when grown west of the Salinas, in what is called the Adelaide country, where more rainfall and cooler nights are the rule. The Estrella is less of an apple than a peach district, from present indications, but apples will undoubtedly thrive there. Fifteen apple trees were set in the orchard this spring (1891), to replace losses; the only new variety was Arabskoe. No losses occurred during 1890 from the tree-borer.

Pears promise even better than the apples. Some two dozen trees were set last spring, and all are growing. Eight new varieties were sent from the Central Station, making the total list something like seventy-five, besides the seedlings and the Japanese stock. Here, as at the Foothill Station, the pear orchard can be increased to more than a hundred varieties without using more land than at present, as seedlings set in orchard form are to be "worked over" as fast as seems desirable. The accurately labeled pear orchards at all the experiment stations appear to me particularly useful on account of the opportunity they afford of correcting and extending local nomenclature, which is much more faulty with pears than with other fruits. The commercial orchards contain only a few kinds, though many of the finest pears known to horticulture have for years been disseminated in family orchards, where their names have been lost. Even at District Fairs I have seen Glout Morceau labeled Bartlett, and Vicar of Winkfield misnamed Easter Beurré.

Almonds continue to surpass all other trees in growth. The wood is firm, the leaves dark in color and healthy, the bark clean. This seems to be a natural almond country. A few trees planted in the swale, and late in the season, died in the winter of 1889, and were replaced. Last spring four new seedling varieties were obtained—the Silver Shell, the Golden State, the Commercial, and the Ne Plus Ultra—and several others will be budded this summer.

Cherries.—No new sorts have been planted since 1889, the collection being large enough for the present. The growth is healthy, but not as strong as could be wished. No gum disease is yet observed. Some losses from gophers were replaced last spring.

Apricots promise far better results on the granite soil, such as the peach enjoys, than on the heavy swale soil. In fact, the apricot, even on Myrobalan stock, "kills out" on the stiff, fine silty soil of the swale, The few on plum stock that survived are very poor. On the lighter, well-drained lands, apricot on apricot, and peach on peach, give the best results. The replanting of last spring was done with reference to these points, and every tree is in fair condition. Luizet and Newcastle Early have been added to the varieties represented.

Peaches and *Nectarines* are extremely successful in both the plots devoted to them, particularly on peach stock, which has made larger growth than the plum stock. A large proportion of the peach and nectarine trees are bearing fruit this year, but it has been "thinned down" to a dozen or less on each tree. So far as I can ascertain two out of three of these bearing trees are on peach stock. Next year fruit may be expected on all or nearly all of the peaches and nectarines. Some of the trees from "dormant buds," often difficult to start, will eventually make as fine trees as any in the orchard.

Plums and *Prunes* show better growth than when last reported upon. This can fairly be attributed to the tile drainage of the swale land. All the gaps caused by dormant buds, late planting, and too wet soil have now been filled, and several new kinds have been added to the orchard. The Japanese plums are some of them bearing this year. Botan is far the most prolific and precocious of these; it deserves a place in every family orchard or garden. The question of stocks will require further observation; there is no appreciable difference between prunes on peach, and prunes on almond or apricot; prunes on Myrobalan seem darker in color of foliage, and slower in growth.

Figs were so badly frosted in the lower portion of the tract, that next year they will be taken up and moved to higher ground. Several new varieties have been planted. The light granitic soil near the buildings suits the figs better, but it is not strong soil, and they grow slowly. The "Bulletin" Smyrna, the Rocardi, and the Adriatic have done rather better than the rest.

Walnuts.—Few trees at the station are more interesting than the English walnuts. All the leading varieties are represented. One tree, a seedling English walnut three years old from the seed-bed, set ten walnuts this summer, a remarkable example of precocity. None of the grafted and named varieties, such as the Præparturiens and Dwarf Prolific, have shown any signs of blossoming as yet; an English walnut ten years old, sent from Berkeley, is likewise without fruit. This early-bearing seedling is, therefore, worth watching hereafter, though this season the nuts were not matured. All the walnuts, most of the chestnuts, and the pecans, are doing fairly, though the latter need more moisture and a stronger soil.

The *Japanese Persimmons* are mostly poor in growth.

Oranges.—These were poor stock originally, and pruned very high, so that the trunks scalded. They are now beginning to root and flourish. They require much water. The leaves are healthy, and the trees were unhurt by the severe frosts of 1889–90 and 1890–91.

Olives.—These are likely to be the pride of the station. Some new olives, among them two of the Berkeley Seedlings, were planted last spring. Nevadillo blanco, Pendulina, Rubra, and a few others blossomed this year.

Small Fruits.—Failure was freely predicted on any or all of the uplands for small fruits grown without irrigation. The station experiments show that thorough cultivation will cause gooseberries, blackberries, and raspberries to grow well and bear largely. A new hybrid between the raspberry and blackberry, obtained at Santa Cruz by the late W. G. Klee, grows very strongly; the canes have red spines and dark leaves, and were well loaded with excellent fruit this season. This berry appears to merit dissemination. The Crandall *blackberry* (unirrigated) is a heavy

bearer. The black-cap class of *raspberry* does better than the red. *Currants* are almost a failure so far, needing more water and shade. Plants three years old have not yet fruited.

Orchard Summary.

The orchard is too young, as yet, to give more than indications of its future. But there are some points of general importance even now. The little fruit borne the present season (1891) is of unusual flavor, though not large. The Japanese plums, for instance, are sweeter and more dry than those grown in the Bay counties. They ought, therefore, to ship better. The peaches are very high in color, and of fine flavor. From the general indications, and from observations made during several journeys over the surrounding country, I think that all the deciduous fruits can be raised without irrigation, in the Paso Robles district, if care be taken in the choice of soils. West of the valley of the upper Salinas the apple orchards improve in quality towards the coast; the peach, prune, and apricot thrive. The almond, in all probability, will only be a safe crop in a few localities, owing to the frosts. I have seldom seen finer three and four-year old plum and pear trees than some on unirrigated hilltops in this west country, five or six miles from Paso Robles. East of the upper Salinas, the hill lands more nearly similar to the soils of the station tract, were for many years thought worthless, except for scanty pasturage. Even now the old settlers find it hard to believe that careful cultivation will make an orchard and vineyard thrive there. The vineyard experiment has already led to the planting of commercial vineyards on similar soils both east and west of the valley.

VINEYARD.

The vineyard is perhaps the most noticeable part of the grounds, for the vines are all well grown, and those of the same variety are remarkably uniform in appearance. There are one hundred and ten kinds represented, and this number will be increased to at least one hundred and fifty the next season, from vines already in the nursery. The vineyard is staked, and shows careful and constant cultivation. At the present season (1891) nearly every vine is well loaded with grapes. No disease whatever has been observed, and very little evil followed the extremely hot weather of early summer. Every gap has been filled with rooted vines.

THE CEREALS.

The interest in the wheats, barleys, and other cereals grown at the station is increasing, and it is evident that much good has been accomplished in the way of the distribution of improved varieties. The following tabulated reports from the Foreman, Mr. R. D. Cruickshank, will serve to show the range of these cultures:

Report on Cereals Grown on Light Soil; Season of 1890–91.

By R. D. CRUICKSHANK.

WHEATS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Volo	Oct. 10	May 3	June 17	Does well here; a very large, solid-stemmed variety.
Black Centennial	Oct. 20	Apr. 29	June 20	Does well; a very handsome wheat; grows tall; stools out well; extra fine variety.
Russian Bearded (Hessian-fly proof)	Oct. 10	May 5	June 17	Good crop.
Palestine	Oct. 10	May 7	June 13	Good crop; very much bearded; good berry.
California Spring	Oct. 10	May 1	June 24	Crop regular; plentiful; fine heads and large berry; extra fine variety.
Royal Australian	Oct. 10	May 1	June 20	Stands at the very head of the list as a milling wheat; does well here.
Petali	Oct. 10	May 4	June 12	Fine heads; very much bearded; does well here.
Pringle's Defiance	Oct. 10	Apr. 27	June 17	Fine long heads; crop uneven; would make good hay.
Nicaragua	Oct. 10	May 1	June 15	Crop good; bearded; not recommended here.
Frankenstein	Oct. 10	May 5	June 15	Grew well; long heads; but not a heavy yield.
Victoria	Oct. 10	May 4	June 18	Partly damaged by water lying and soil subsiding; test not fair.
Taganrog	Oct. 10	Apr. 26	June 15	Did well; a showy wheat of the solid-stemmed style.
Red Club, or Hedgehog	Oct. 10	May 2	June 19	Did well; a curiosity; not heavy crop; birds fond of it; much eaten by them.
Imperial	Oct. 10	May 3	June 17	Crop good; showy.
Champlain	Oct. 11	May 9	June 20	Not adapted for grain here, but would make good hay.
Ghurka, or Odessa	Oct. 11	May 4	June 19	Grew well; bearded; not recommended here.
Harris from Jasper	Oct. 11	May 3	June 16	Grew well; stool enormous; better for hay than grain.
Blue Glass	Oct. 11	Apr. 29	June 19	Grew well; large heads; peculiar on account of color.
Missoyen	Oct. 11	May 1	June 20	Very fine crop; solid-stemmed variety.
Greek Atlanti	Oct. 11	May 2	June 18	Crop splendid; heads large; straw strong; stem solid.
Polish, or Diamond	Oct. 11	Apr. 29	June 13	Did well; a curious variety, called wild-goose wheat, used for vermicelli.
Indian, three months	Oct. 15	Apr. 10	June 13	Sonora type; did well and made fine hay.
Arizona Indian Seed Wheat	Oct. 15	Apr. 6	June 13	Did very well; Sonora type; if sown thick, makes good hay.
Snowflake	Oct. 15	May 8	June 20	A very showy variety; did well; would make fine hay.
Tunisian	Oct. 15	Apr. 28	June 20	Did well; solid-stemmed, tall.
Archer's Prolific	Oct. 15	May 5	June 13	All that could be desired; type same as Propo; heavy yield.
Whittington	Oct. 15	May 2	June 13	Good crop; beardless; probably too soft.
Genoese	Oct. 15	May 5	June 13	A fine crop; a first rate red wheat.
Pringle's Best	Oct. 15	May 9	June 13	Not valuable for grain; would make good hay.
Yellow Noé	Oct. 15	May 12	June 18	Grew well; leafy straw; make fine fodder.
Indian Winter	Oct. 15	May 5	June 20	Grew well; stooled out very fine; small grain; extra fine for hay.
Fern, or April	Oct. 15	May 6	June 29	Heavy crop; bearded; not recommended.

WHEATS—Continued.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Clawson	Oct. 15	May 6	June 13	Grew well, but too strawy.
Touzelle	Oct. 15	May 8	June 13	Grew well; club type; birds partial to it; good for hay.
Thuringian	Oct. 15	May 13	June 15	Grew well; highly recommended for fodder; immense stool.
Improved Circassian	Oct. 15	May 12	June 13	Crop heavy; liable to shrink in berry.
Egyptian	Oct. 15	May 12	June 20	Splendid crop. A curiosity by having seven heads; not very good for milling.
Mold's Red Winter	Oct. 15	May 9	June 13	Seed was poor; but if under favorable conditions would make good hay.
Blood Red Indian	Oct. 15	May 7	June 19	Crop regular; beardless.
Chile	Oct. 15	May 5	June 13	Did well; not heavy, but very regular; beardless.
Red Sonora	Oct. 15	May 3	June 13	Very fine regular crop. If sown thick would make the very finest hay. It does well in hot upland.
Red-Bearded	Oct. 10	May 3	June 8	Did well, but birds destroyed before ripe.

BARLEYS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Himalaya	Oct. 15	Apr. 6	June 1	Remarkably heavy crop.
Small Blue Naked	Oct. 10	Apr. 12	June 8	Good crop; misnamed—not blue.
Hallett's Pedigree	Oct. 15	Apr. 28	June 8	Extra fine crop; Chevalier type.
Manchurian	Oct. 11	Apr. 6	May 23	The earliest; subject to breaking down.
Kalina	Oct. 11	Apr. 6	June 1	Did very well.
Black, six-rowed	Oct. 15	Apr. 25	June 8	Did well.
Imperial	Oct. 10	Apr. 15	June 8	Good crop.
Italian	Oct. 10	Apr. 19	June 8	Did well; very pretty.
Chevalier	Oct. 15	Apr. 20	June 8	Did well, but better on adobe.
Six-rowed	Oct. 11	Apr. 12	June 1	Fine crop.
Bluish	Oct. 11	Apr. 13	June 1	Did well; liable to get broken by wind.
Scotch, two-rowed	Oct. 15	Apr. 19	June 8	Did well.
Carter's Prolific	Oct. 15	Apr. 10	June 8	Heavy crop; Chevalier type.
Large Naked, two-rowed	Oct. 11	Apr. 5	June 1	A very heavy crop.
Nepaul	Oct. 11	Apr. 10	June 1	Did well; good for hay.
Rice, or "Sprat"	Oct. 15	May 5	June 11	Heavy crop; great curiosity; very contorted.
Department of Agriculture No. 6	Oct. 15	Apr. 10	June 8	A new barley received in 1890 from Department of Agriculture, Washington. Excellent heavy crop.

OATS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Scotch Hopetown	Oct. 10	May 4	June 17	Can be highly recommended in this section for milling.
Gray oats from Houdan	Oct. 10	May 5	June 25	No use here, too late to come to maturity; has been the same three years.
Early oats from Georgia	Oct. 10	May 5	June 25	No use; too late in ripening.
Bald oats	Oct. 10	May 7	June 16	This oat does well; would make fine oat hay; it has no beard, and plenty of leaf.
Early August	Oct. 15	May 9	June 25	Good style, and does fairly well.
Surprise	Oct. 15	May 10	June 15	Does well, and can be recommended.
Black Tartar	Oct. 15	May 10	June 25	Does not do well; all straw.
White Wonder	Oct. 15	May 6	June 25	A very prolific oat; does well; came from the Department of Agriculture, 1890.
E. K. Carr, Texas	Oct. 11	May 6	June 8	Suitable for this section; has done well three years here.
Canadian	Oct. 10	May 2	June 26	Not adapted for this section; ripens imperfectly.

RYES.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Perennial Saxon	Oct. 10	Apr. 28	June 25	Did extra well.
St. John's Day	Oct. 10	May 5	June 27	Made very handsome heads; recommended.
Swedish Sand	Oct. 10	Apr. 28	June 25	Made very large stool; fine.
Excelsior Winter	Oct. 10	May 5	June 20	Did well; fine, even crop.
Spanish Double-bearing	Oct. 10	May 5	June 25	Did splendidly; made very fine stools.

SPELTS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Common White-Bearded	Oct. 10	May 5	June 26	Did extra well.
Red Emmer	Oct. 15	May 12	June 26	Did the poorest of all the spelts tried.
White Silesian	Oct. 10	May 12	June 26	Medium crop; did fairly well.
White Emmer	Oct. 15	May 9	June 28	Grew well, but points blasted.

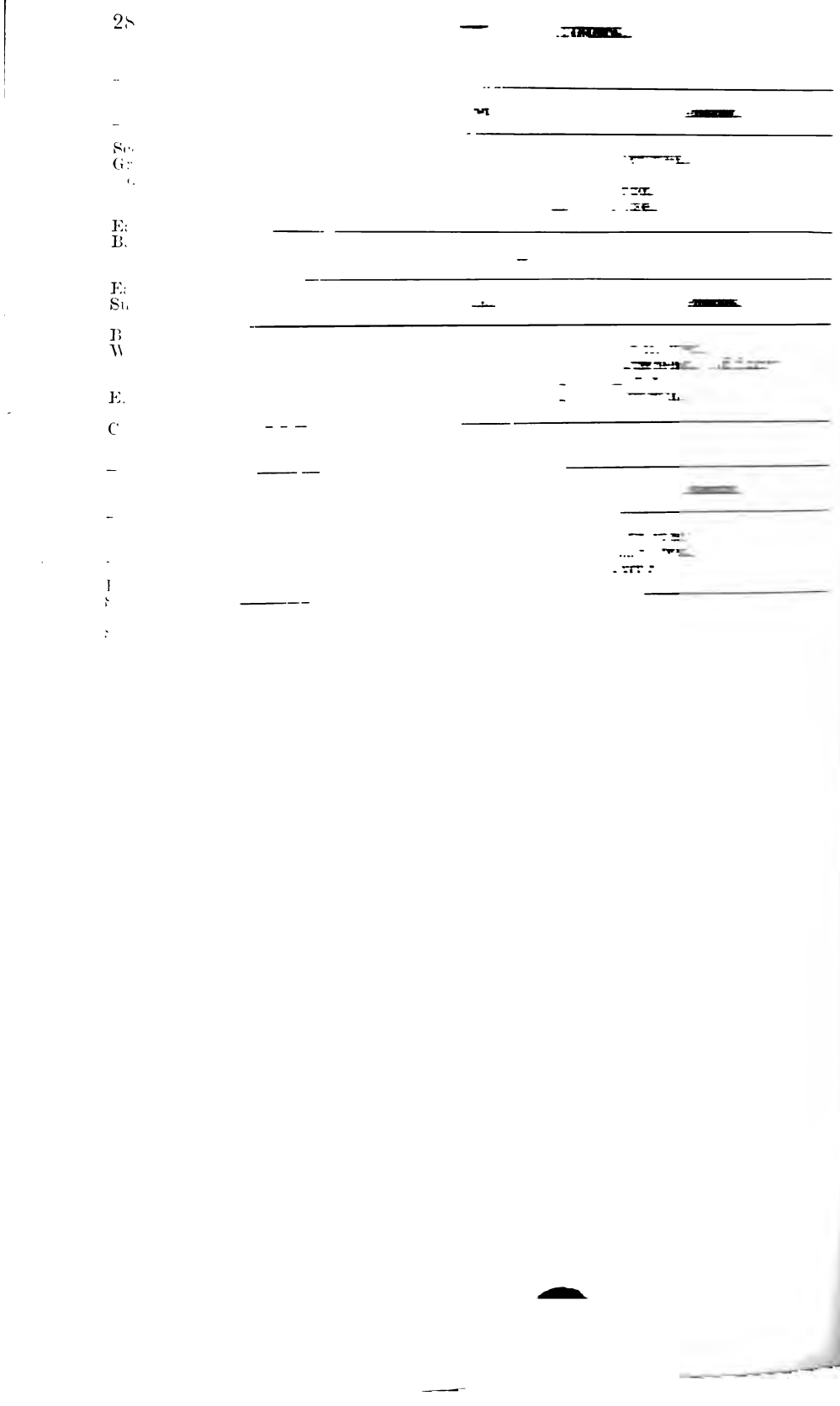
Report on Cereals Grown on Adobe Soil; Season of 1890–91.

WHEATS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Missoyen	Dec. 26	May 2	June 22	Heavier heads than on the light soil; very fine, solid-stemmed variety.
Greek Atlanti	Dec. 26	May 5	June 20	Splendid crop; noble heads.
Diamond, or Polish	Dec. 26	May 10	June 18	Crop splendid; evidently does to perfection on adobe; tapioca variety.
Palestine	Dec. 26	May 8	June 15	Did not do so well as on light soil.
Oregon Club	Dec. 26	May 9	June 25	Very fine; yields well.
Centennial	Dec. 26	May 15	June 24	Strong, handsome variety; quality fine.
Hallett's Pedigree (White Victoria)	Dec. 26	May 11	June 20	Very fine.
Mold's Red Winter	Dec. 26	May 9	June 19	Seed was old; does not look promising.
California Spring	Dec. 27	May 3	June 25	One of the finest; can be highly recommended for trial.
Russian Bearded (Hessian-fly proof)	Dec. 27	May 5	June 20	Fine crop; does well here.
Propo	Dec. 27	May 9	June 15	All that could be desired; in great favor about here.
Blue Glass	Dec. 27	May 9	June 20	Fine crop; peculiar metallic color.
Frankenstein	Dec. 27	May 6	June 25	Not very good; too light crop.
Fern, or April	Dec. 29	May 12	June 13	Did well, but a little irregular.
Forelle	Dec. 29	May 12	June 13	No good on adobe.
Petali	Dec. 29	May 13	June 15	Did well.
Taganrog	Dec. 29	May 15	June 18	Did well.
Nonpareil	Dec. 29	May 9	June 21	Fine, even crop; long heads.
Whittington	Dec. 29	May 9	June 20	Did very well.
Chiddam	Dec. 29	May 6	June 19	The poorest of any.

BARLEYS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Hallett's Pedigree of Chevalier.	Dec. 26	April 28	June 9	A very fine barley; an improvement on the ordinary Chevalier.
Early Black, two-rowed	Dec. 26	April 27	June 9	Very fine, heavy crop.
Italian	Dec. 26	April 19	June 13	A very fine crop.
Scotch, two-rowed	Dec. 26	April 15	June 14	Fine crop; regular.
Carter's Prolific	Dec. 27	April 10	June 13	Did extra well; straw short.
Early Black, six-rowed	Dec. 27	April 25	June 9	A very heavy crop.
Kalina	Dec. 27	April 6	June 9	A very fine crop.
Large Naked, two-rowed	Dec. 27	April 5	May 12	A heavy yield; grain large.
Department of Agriculture No. 2	Dec. 27	April 6	June 18	Did first rate.
Six-rowed (Brenner)	Dec. 27	April 7	June 18	Did very well.
Berkeley Hybrid	Dec. 27	April 5	June 9	Does well; a fine variety for straw.
Six-rowed (Winter)	Dec. 29	April 12	June 15	Did first rate.
Small Naked	Dec. 29	April 12	June 9	Did well; heavy yield.
Department of Constantine No. 2	Dec. 29	April 12	June 13	Did first rate; heavy crop.
Himalaya	Dec. 29	April 10	June 15	Finest crop of all.
Department of Agriculture	Dec. 29	April 10	June 15	Did very well; a good barley.
Chevalier	Dec. 29	April 5	June 13	Did well; heavy crop.



D. SAN JOAQUIN VALLEY STATION.

One mile southeast of Tulare City, Tulare County.

By CHARLES H. SHINN.

None of the stations have greater difficulties to contend with than the station near Tulare City, and none are of more interest, present and prospective. The soil chosen is considered very poor by some farmers, and yet the results of cultivation have been surprisingly good. The alkali of different grades that exists in spots on the tract offers every opportunity for experiments with new cultures, and with systems of reclamation. It is more and more evident that while this station will never present the uniform excellence of the Pomona or the Amador stations, it is one of the most important experiment stations in the United States, because it is representative of an immense area of soils at present utilized but little, or not at all—soils, too, that possess all the elements of plant-life, and are of very great intrinsic value. The site was chosen on account of the special advantages it offered for experimenting with such soils. The first task is to determine what plants thrive on alkali; next, to experiment with methods of modifying or reclaiming such soils.

THE ORCHARD.

The general appearance of the orchard is improving. Many dormant buds failed in 1888–89 and were replanted; others on bad alkali have failed to some extent and were reset on different stock. As a consequence the orchard is extremely uneven, and will be so for several years longer. Last winter (1890–91) there were less than fifty trees reset, and those only in small spots of strong alkali. The total planting of the last season was about one hundred fruit trees, including many new varieties, a number of olives and figs, and the Persian date palms, elsewhere described.

Apricots have made a fine and sturdy growth of from three to six feet. Those on light alkali gain more slowly, but are healthy, particularly the seedlings. Those on strong alkali died, and have been reset with a wheelbarrow-load of sand and a dressing of plaster about them. The apricots are near to the main street, at the east of the station, and a row of olives is planted along the fence. Seedling palms are outside, along the road.

Peaches, which come next to the apricots, have made a still better growth, and a little fruit was borne this season. The alkali affected them in much the same way as the apricots. The peach orchard touches two spots of alkali, one of very strong black, the other lighter, on the main avenue. A wheelbarrow-load of sand gives temporary aid, but under-drainage and leaching the surface, together with a dressing of plaster, are necessary to remove the surplus alkali. The surface soil is scraped away and the sand and plaster put about the roots. Peach

OATS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Bald	Dec. 29	May 10	June 17	Did very well.
Gray oats from Houdan	Dec. 29	May 3	June 20	Not good.
Canadian	Dec. 29	May 2	June 20	Of no use.

SPELTS.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
Black Emmer	Dec. 27	May 6	June 20	Did not fill well.
Red Emmer	Dec. 27	May 5	June 20	Not large head; did fairly.
White Silesian	Dec. 29	May 10	June 21	Light crop.
White Emmer	Dec. 29	May 8	June 23	Did very well.

RYES.

Varieties.	Sown.	Bloomed.	Cut.	Remarks.
St. John's Day	Dec. 29	April 5	June 25	Did very finely.
Excelsior Winter	Dec. 29	April 6	June 25	Did fairly well.
Perennial Saxon	Dec. 29	April 7	June 26	Even crop.

D. SAN JOAQUIN VALLEY STATION.

One mile southeast of Tulare City, Tulare County.

By CHARLES H. SHINN.

None of the stations have greater difficulties to contend with than the station near Tulare City, and none are of more interest, present and prospective. The soil chosen is considered very poor by some farmers, and yet the results of cultivation have been surprisingly good. The alkali of different grades that exists in spots on the tract offers every opportunity for experiments with new cultures, and with systems of reclamation. It is more and more evident that while this station will never present the uniform excellence of the Pomona or the Amador stations, it is one of the most important experiment stations in the United States, because it is representative of an immense area of soils at present utilized but little, or not at all—soils, too, that possess all the elements of plant-life, and are of very great intrinsic value. The site was chosen on account of the special advantages it offered for experimenting with such soils. The first task is to determine what plants thrive on alkali; next, to experiment with methods of modifying or reclaiming such soils.

THE ORCHARD.

The general appearance of the orchard is improving. Many dormant buds failed in 1888–89 and were replanted; others on bad alkali have failed to some extent and were reset on different stock. As a consequence the orchard is extremely uneven, and will be so for several years longer. Last winter (1890–91) there were less than fifty trees reset, and those only in small spots of strong alkali. The total planting of the last season was about one hundred fruit trees, including many new varieties, a number of olives and figs, and the Persian date palms, elsewhere described.

Apricots have made a fine and sturdy growth of from three to six feet. Those on light alkali gain more slowly, but are healthy, particularly the seedlings. Those on strong alkali died, and have been reset with a wheelbarrow-load of sand and a dressing of plaster about them. The apricots are near to the main street, at the east of the station, and a row of olives is planted along the fence. Seedling palms are outside, along the road.

Peaches, which come next to the apricots, have made a still better growth, and a little fruit was borne this season. The alkali affected them in much the same way as the apricots. The peach orchard touches two spots of alkali, one of very strong black, the other lighter, on the main avenue. A wheelbarrow-load of sand gives temporary aid, but under-drainage and leaching the surface, together with a dressing of plaster, are necessary to remove the surplus alkali. The surface soil is scraped away and the sand and plaster put about the roots. Peach

on Myrobalan stock, though of poor growth, resists the alkali better than peach stock—in twelve cases of Myrobalan stock, all survived except one. Other plum stocks, in as great variety as possible, ought to be tested on such soils.

Plums generally have done best on the sandy soil. Some of the strongest alkali has been too much for some varieties of plums, but a second setting there appears better. Yellow Gage, Imperial, Prince Englebert, McLaughlin, Bryanstone Gage, Ickworth Imperatrice, Early Golden Drop, and Prunus Simoni, have stood the alkali very well. Orange plum and Bleecker's Gage have survived some of the very strongest black alkali on the tract, but Masu, Botankio, Kelsey, Burbank, and the Long-fruited Japan, do not stand it nearly as well as the European plums. The German prunes are in two different spots of alkali, and do fairly well in both; Prune d'Agen has failed in the stronger alkali. Some dormant plum buds in alkali did but poorly. Robe de Sergent prune stands the alkali, and so does the Datte de Hongrie. One of two Wangenheims on alkali soil is doing well. The conclusion from two years' observations is that the Japanese plums are most sensitive to alkali; that several of the *Prunus* resist it better than other European plums do; and that *Prunus Simoni* is particularly hardy.

Nectarines.—A bad record; worse than that of any other fruit. Hardwick stands light alkali, but this, as well as all other kinds, put on stronger alkali, succumbs more rapidly than the apricot or peach. Eleven out of twenty-five trees set in 1888–89 had succumbed to alkali before the spring of 1891.

Apples.—In some cases more than a fair growth, but on rather light apple soil, and usually of slow growth. There is little alkali in the apple tract; wherever it appears the effect is immediately seen. Walbridge has made some growth in alkali, where the Lady apple and Huntsman died.

Almonds.—The strongest alkali in the almond orchard was never planted, as it was useless to do so. Almond trees grown in the Napa and Sonoma Valleys made a very poor start, and soon failed; stock from San José, Stockton, and the home station did much better. The California seedling varieties make a far stronger growth than the Languedoc.

Pears.—Strong alkali is on one end of the tract, making an excellent test. Mount Vernon, Onondaga, Jaminette, Doyenne d'Alençon, Barry, Pound, Glout Morçeau, Louise Bonne de Jersey, Flemish Beauty, Easter Beurré, Lawrence, and some other varieties are doing well in alkali soil; B. S. Fox failed there. The Chinese type of pear seems particularly well adapted to the climate. Japanese seedlings promise to be of value for stocks.

Olives.—It is a very gratifying fact that the olive grows well in soils where the peach, apricot, almond, and nectarine are destroyed by the black alkali. Trees planted in 1889–90 and others in 1890–91 are alike successful. The best growth is on the light alkali soils; the light sandy soil, free from alkali, is but poorly adapted to the olive. The common Mission olive does well in alkali soil, near San Francisco Bay, and large trees are growing in such soil in Santa Clara County. At the station there is little difference yet between varieties, excepting that Nevadillo blanco and Pendulina are doing especially well.

Figs.—Some of the fig trees at the station are superior in appearance

to those at Amador or Paso Robles. This refers only to those on the ordinary soils; a few on strong alkali have perished, but were replaced, with extra precautions, using plaster as a dressing. Angelique, California Black, Raby Castle, and Glossale are the failures so far. Smyrna and White Adriatic promise unusually well.

Other Plants.—Among the trees and shrubs well adapted to the region are the carob, the Kai apple, the camphor, and the common purple guava. The oranges made a much better growth this season (1891). The sour Florida stock started slowly, the roots being poor. The dwarf Japanese kinds promise entire success. Among the walnuts the California seedling soft-shell variety has made the best growth. Chestnuts suffer from the heat, even if protected. *Ficus Australis* and *F. macrophylla* both thrive with little care. All the mulberries are entirely at home in the district. Bamboos need care to start, but do well when established. The basket willows are grown with the greatest ease, if supplied with plenty of water, and the farmers are beginning to plant them more extensively. The California maple does but poorly, but the cork elm can be recommended.

THE CEREALS.

Wheat.—The problem in wheat-growing at all the stations has been to produce satisfactory results at small expense, and under practical conditions. Every farmer who visited the Tulare station expressed his surprise at the crops obtained without irrigation. All the wheats were planted in drills six inches apart. The wheat and barley plots were adjacent; nearly one half of the soil devoted to these two cereals was strongly alkaline. The ground was deeply plowed and cross-plowed, and pulverized almost to dust. The wheat was sowed before the rains began. The seed was divided into parcels, and soaked for from half a day to five days in bluestone, some farmers having claimed that long soaking spoils the germs; but all the parcels of seeds grew equally well. One and a half ounces were sown to each one hundred and forty-five feet of drill. The wheats began to ripen in the latter part of May, and continued into June. Petali, Diamond, Blue Glass, and Archer's were among the earliest.

The following table shows the yield, and the soils on which some leading varieties of wheat were planted; each kind occupying one hundred and forty-five feet of drill:

Table Showing Yield of Wheat, and Character of Soil.

NAME OF VARIETY.	Yield of 145 Feet of Drill—Pounds.	Soil.
Arizona	23.25	Half alkali.
Archer's Prolific	33.50	Half alkali.
White Club	12.50	All alkali.
California Spring	46.00	Half alkali.
Chile	30.75	Half alkali.
Greek Atlanti	32.50	Sandy soil.
Pringle's Best	25.25	Half alkali.
Pringle's Defiance	19.25	Half alkali.
Palestine	23.25	Half alkali.
Petali	25.00	Half alkali.
Thuringian	13.50	Half alkali.
Whittington	37.50	Half alkali.
White Banat	9.25	Half alkali.
Michigan	19.75	Alkali.
Missoyen	22.00	Half alkali.
Egyptian	13.25	Half alkali.
Royal Australian	32.00	Half alkali.
Red-bearded Russian	21.00	Half alkali.
Sonora	12.50	Half alkali.
Volo	27.50	Half alkali.
Yellow Noé	16.75	Half alkali.

The above named wheats, in most cases, yielded rather more than twice as much on the good soil as on the alkali. The Russian (red-bearded) only yielded one third as much on the alkali as on the good soil, but Sonora and Yellow Noé, both light crops, yielded four fifths as well. Many other wheats besides those tabulated were tested with useful results. Clawson, Black Centennial, Champlain, Frankenstein, Probst, Snowflake, and Odessa may be classed as entire failures on alkali soils. The Chile stands drought well; so do Archer's Prolific, Michigan, and Palestine. Among the kinds that lodge badly are the improved Circassian, Nonette Lausanne, and Nicaragua.

Barleys.—The best barley tested for hay was the Berkeley Hybrid, sown broadcast, 288 pounds of seed to the acre. Of the drilled barleys the Blue yielded 21.5 pounds per drill of one hundred and forty-five feet. Carter's Prolific yielded 15.5 pounds, Chevalier yielded 19 pounds, and the Early Black the same. The most prolific barley was the Himalaya, which yielded 48 pounds. It will be noted that this is one of the best bearing kinds at the other stations also; it can be confidently recommended. Another excellent sort is the Italian, which yielded 33 pounds. The Manchurian yielded 28 pounds. Some of the other yields were as follows: Hallett's Pedigree, 13 pounds; Brenner, 5.5 pounds; Nepaul, 21 pounds.

Rye.—The Excelsior, in drills of one hundred and forty-five feet in length, yielded 12 pounds; the Swedish, 7 pounds; St. John's Day, 16.5 pounds; the Saxon Perennial, 19 pounds. The Spanish was the best, yielding 22.25 pounds. All these were sown in strong alkali soil.

Oats.—The oats were sown too late, but the following did fairly well: Canadian, Gray Oats, Scotch Hopeton, oats from E. K. Carr of Texas, Early Oats from Georgia, Surprise, White Bolognese, Early August, Black Tartary. All of these were sown in alkali soil. The best varieties tested this season (1891) were: Surprise, Winter Bolognese, Early Black, and the Gray Oats from Houdan.

Spelts.—White Silesian (in the usual drill) gave 9.5 pounds; blue-

bearded gave 8.25 pounds; the common white-bearded gave 5.5 pounds. All the spelts were on alkali soil. Spelt is a mountain grain, chiefly sown where wheat does not thrive, and it is but poorly adapted to the warm San Joaquin region.

GRASSES AND CLOVERS.

The Hungarian brome grass stands drought well, and is recommended. Shrader's brome is rather better than the Hungarian. The Australian ray grass is another excellent sort. The climate is too dry for timothy. The Soft Meadow grass does fairly in the season, but needs a great deal of water. Italian ray grass, after three years' trial, ranks at the head of the list. *Agropyrum glaucum* ("blue stem") stands drought, and becomes deeply rooted. The Red Fescue does but poorly. The red and white clovers are excellent the first part of the year; need much water. The yellow bird's-foot clover is much the same after two seasons' trial, but stands drought better than red and white clovers. *Anthyllis vulneraria* is a failure. *Hedysarum coronarium* grows well on alkali soil; it stood three feet high this season, and yielded heavily. The Bokhara clover thrives with little or no water, striking deep roots, and growing four feet high.

The grasses and clovers were not watered at all until July, and then but little. They were watered again in September. The effort has been to grow them, as far as possible, without irrigation. Several other forage plants have proved of value; the sainfoin (esparcette) is one of the best.

COTTON.

Experiments show that the future of cotton culture is highly promising. Two varieties were planted, "Big Boll" and "Poor Man's Relief," in drills, March seventeenth. They yielded, with little irrigation, at the rate of a bale (four hundred pounds) to the acre. This was on light soil, some of it alkali.

OTHER CULTURES.

Ramie is an entire success, even on light alkali soils, and has been distributed to many farmers. Six kinds of flax were sown, but they grew only about a foot high; it is evidently not adapted to the soil and climate. Jute was sown, but the frosts of the following winter killed it. Sugar-beets of the best varieties have done fairly on the sandy soils, but failed on the alkali. It is hardly the place for beet culture, though there is plenty of good soil for this crop in the region. The mangolds do better than the sugar-beets. Twelve varieties of sorghum are grown and used for fodder; they produce fairly on the alkali—perhaps half as much as on the ordinary soil. Japanese buckwheat is the best of the buckwheats, but the climate is too hot for this crop. The Chick pea and the Algerian pea grow well.

E. SOUTH CALIFORNIA STATION.

Near Pomona, Los Angeles County.

By CHARLES H. SHINN.

Since the last report was issued a new station has been established—that of South California, in the Chino Valley, near the town of Pomona. This valley is one of the best known localities in the State, and possesses many and especial advantages for an experiment station. The reasons which led to the selection of the place were amply set forth in the following extract from Prof. E. W. Hilgard's letter to the Board of Regents:

BERKELEY, July 14, 1890.

Regent J. F. HOUGHTON, *Chairman Committee on Experiment Stations:*

DEAR SIR: Pursuant to the decision of the Regents locating the station for South California near Pomona, I have at once revisited that locality in order to expedite matters as much as possible, and insure the beginning of operations for the coming season; also, in order to determine which of the alternative offers made of tracts of land should be accepted.

I returned last evening, and as the result of my further investigation, would recommend the acceptance by the committee of the offers made by Mr. Richard Gird, of "thirty acres of land described in the first offer" (located on Sec. 34, T. 1 S., R. 8 W.), "with a proportionate amount of water, and ten acres of the naturally moist land described in the second proposition herewith."

From a detailed inspection, I find that the thirty-acre tract will have about five sixths of the reddish mesa soil that is deemed specially appropriate for citrus fruits, and one sixth of the gray gravelly soil that characterizes the "washes" of the Sierra Madre. In order to include this large proportion of the mesa soil proper, it will be necessary to have the tract somewhat "L" shape.

For the location of the detached tract of ten acres, I explored in detail the northern limit of the moist lands, in order to obtain it as near the other tract as possible without detracting from its special character. I found this realized in a ten-acre tract near the center of Sec. 10, T. 2 S., therefore a trifle over two miles due south of the main tract, from which an avenue runs directly to it, minimizing the distance to be traveled by teams.

While this adoption of the plan of two distinct tracts will increase somewhat the expense and trouble of the station work, it seems difficult in this case to do justice to the region intended to be represented by the station, without such segregation. The dark loam soil of the moist lands is extensively represented not only in the interior valleys, but also along the coast, and its capabilities should be thoroughly tested. The ten-acre tract is sufficiently large to permit us the covering of expenses, in part, by the growing of hay for the team, as the land is profusely productive, and four out of the ten acres would probably suffice for the ten tons of hay needed. I therefore recommend the acceptance of these two tracts.

Work at the Station Begun.—The home tract chosen, on which the buildings are placed, is situated three miles southeast of Pomona. The whole region about it is rapidly developing, and will soon be a continuous garden and orchard. Sugar-beet culture is being carried on in the vicinity by Mr. Richard Gird and others, on the largest scale known in California. Large orchards of figs, oranges, olives, prunes, walnuts, and other fruits are being planted, and the nurseries already established serve to make the valley a notable center for horticultural industries.

Late in November, 1890, the University assumed charge of the station, sending Mr. K. McLennan, formerly Foreman of the Central Station, to lay out the grounds and begin work there. The building was not ready

for occupancy, and the Foreman had to live at Chino for several weeks after his arrival. Mr. Gird, the donor of the station, kindly gave the use of a horse and outfit to the Foreman for two months, so that he could drive to and from the town. Two large and strong work horses were bought, and the work of clearing the ground of weeds and brush, and leveling it fit for planting and irrigation, was commenced by the middle of December. A third horse was bought in April.

Water Supply.—When the station was established, an ample supply of water was delivered at the highest corner of the tract, through a three-inch cement pipe laid from Mr. Gird's main reservoir, one mile distant. Owing to various leaks and breaks during the winter, it was sometimes difficult to obtain water, but the flow is now steady and constant. The water is delivered at the northeast corner of the station grounds. Here a six-inch stand-pipe of cement raises the water four feet. Some three hundred and twenty-five feet of inch pipe (iron) is used to conduct water to the barn and house. The pressure is very weak, but it is doubtful whether the cement pipe would stand a much higher stand-pipe. It will be necessary to build a permanent reservoir of cement in order to utilize the supply of water, which is ample for all purposes if properly saved. Otherwise, as the demands of the growing population increase, it will probably be found that the station can only have water on certain days.

Preparation of the Tract.—The whole thirty acres was first broken with a twelve-inch plow, "driven to the beam," and was afterwards cross-plowed. Clearing, plowing, grading, and laying out the roads and plots occupied the entire time of the Foreman with two workmen and two teams, from early in December to the middle of February. The grading has been well done and insures easy irrigation so soon as a reservoir is built. February 19, 1891, the shipments of trees and plants began to arrive at the station. But the great rainstorm of February twenty-first and twenty-second flooded a portion of the valley, and washed gravel and mud over a part of the tract, destroying much of the work already done. An extra month of labor was required to prepare the ground for the orchard, and the whole tract was again plowed and cross-plowed as soon as the weather would permit. This particular "wash," or overflow, occurs at long intervals, but now has been guarded against, in a measure at least, by the people of the region, and is never sufficient to injure established crops.

Fencing, Farm Buildings, etc.—It was necessary to protect the orchard from rabbits. Nearly four thousand feet of woven wire fence was put up last summer, inclosing eighteen acres of the tract, and leaving twelve acres unfenced. Cattle are at large on the bottoms, and it will be advisable to strengthen the fence with a six-inch board. In a few years no fencing will be necessary, excepting around the small culture plots and nursery, for the whole valley is rapidly coming under cultivation.

The stable has a hay-loft, work-room, and wagon-shed, with a yard for exercise behind the building, much like the other station, except that less space is given for the yard. The main station building is similar to the one at the Tulare station, described in previous reports, and seems to be adapted to the work required. It was built according to plans and specifications furnished by the University.

THE ORCHARD.

Owing chiefly to the delays caused by the overflow, planting was not begun till March thirtieth, and was completed by the middle of April, fully a month later than is desirable in the Pomona region, particularly for deciduous trees. The main orchard now contains seven hundred and thirty-eight trees and three hundred and sixty-five varieties. It lies east and south of the house. The square system is adopted in planting. The trees are set twenty-four feet apart each way, making seventy-six trees to the acre, and allowing an opportunity for some dwarf trees, small fruits, and miscellaneous cultures between the rows for a few years at least. The trees have been irrigated six times, each tree receiving six or eight gallons at a time. A strip of about four acres of easily-worked and excellent land is left north of the orchard, next to the road, for small cultures and nursery. This strip is one hundred and fifty feet wide at the house, and sixty-eight feet wide at the western end.

Olives.—There are now twenty-one varieties established here, nineteen of which were two and three years old, grafted. These were received from the California Nursery Company, at Niles. One Mission, one year old, grown from small cutting, was donated by A. P. Simpson, Pomona. Two Empeltres, two years old, also grown from small cuttings, were donated by Alfred Wright, Pomona. All the olives are making good growth, and are doing as well as could be expected the first season.

Citrus Fruits.—Three varieties of lemon were planted. They were two years old from the bud, and were purchased in Pomona. They show a remarkably strong growth for the first year.

Of citron three varieties are planted, all two years old, budded on orange stock. These were received from F. A. Kimball, of National City, and arrived in poor condition. Two of them have made a feeble start. The names of these new citrons are Sorrento, Calabria, and Amalfi.

Eight varieties of oranges were received from Twogood & Cutter, of Riverside. These were three years old, and budded on sour stock. Another lot of oranges were received from Mr. Howland, Pomona, seven varieties, two and three years old, and budded on sweet stock. All the oranges show a remarkably vigorous growth, and we cannot yet see any marked difference between the growth of the sweet and the sour stocks.

Almonds.—Fourteen varieties were received from the California Nursery Company. They made a very good growth; there are but two backward ones in the lot.

Cherries.—Ten varieties were planted, all one year old. They are all living and doing well.

Peaches.—Thirty-seven varieties are budded on peach stock. Fourteen varieties are on Myrobalan stock. The latter started earlier than those budded on the peach stock, and made a very good growth. All the peaches have done admirably.

Nectarines.—Received from the Central Station nurseries, eight varieties, one year old, budded on peach stock. They were strong trees, and have made a splendid growth.

Apricots.—Eleven varieties, one year old, budded on apricot stock, were received from Niles. All the apricots made a large, strong growth. From the Central Station, five varieties were sent, one year old, budded on peach stock.

Plums and Prunes.—Five varieties of plums were planted, one year old, chiefly on Myrobalan stock. Some of them made a growth of three to four feet. Eighteen varieties of prunes were planted, mostly on Myrobalan stock, though other stocks are represented. Eight varieties of Japanese plums are also planted.

Pears and Apples.—Twenty-five varieties of pears, one year old, were bought. Forty-five varieties were sent from the Central Station. The pears suffered more from the heat, and made less growth, than any other deciduous trees. The apples also suffered heavily during a hot spell, though they made a good start. Forty-six varieties, largely southern sorts, were planted here.

Figs.—Some of the trees sent were too large. The small trees from the Central Station did much better than those bought outside. Mr. McLennan, the Foreman, states that his experience with figs is especially favorable to small trees, not branched, and of from say one to two feet in height. They start quicker and grow faster than larger trees. Twenty-two varieties were planted.

Condition of Orchard.—At the present time the orchard shows careful handling, and looks well. It will need more water next summer. Some trees have died, owing to lateness of planting, but the loss is not more than twenty-five in the whole orchard, and these of varieties easily replaced. The peaches, plums, prunes, and apricots present a most satisfactory appearance. So do the citrus fruits, olives, and figs. Some loquats, one a new variety, donated by J. S. Calkins of Pomona, and some other Japanese fruits, are doing well.

THE VINEYARD.

Seventy-five varieties of grapes have been planted in the nursery, and next spring, together with many additional varieties, will be planted in regular vineyard form. Among these will be the new Persian grapes recently sent out by the United States Department of Agriculture, and those lately imported from Italy.

DATE PALMS.

Nine named varieties, mostly from Persia, imported by the United States Department of Agriculture, are now planted near the house, and will, in time, form one of the most prominent features of the station. The last added to the collection is the famous Fard date. Seedling dates and some other palms have been planted, but none of the ordinary species generally used for ornament. The Persian dates have all made a fine growth.

NOTES ON OTHER PLANTS.

The camphor tree did poorly, suffering extremely from the heat. So did the *Cryptomeria Japonica* (Japan cedar). The strawberry tree (*Arbutus unedo*) is also a slow grower here, and is probably not suited to the climate. *Magnolia grandiflora* and *Edwardsia grandiflora* grow slowly; the former scorches in the sun, and so does the garden laurustinus (*Viburnum tinus*). Fuchsias suffer greatly from the winds. Heliotropes and chrysanthemums do well in the garden, when sheltered. *Pittosporum odoratum* does fairly well so far. The acacias thrive. *Ficus*

macrophylla made a good growth, but may suffer somewhat in winter. *Fabiana imbricata* is another of the successes. *Metrosideros buxifolia* is also a fine grower here. The best of the guavas so far is the *pomiferum;* the *Cattleyanum* seems to start but slowly. Among other trees and plants that seem to suit the place particularly, the Foreman reports the Mediterranean heath, the *Capparis spinosa*, or caper bush, and the carob (*Ceratonia siliqua*).

The Chinese tea plants were small when planted, and have made a very slight growth. The bamboos were nearly as bad. The climate is hot for camellias. New Zealand flax has hardly started, but will do better when it has more water. The *Citrus trifoliata* appears to be exactly adapted to the region.

The experiments of the past summer in ornamentals were extended by gifts of plants from gentlemen in the vicinity. A complete list of these donations follows. Japanese persimmons, pomegranates, new varieties of eucalyptus, several *Passifloras*, and a large number of useful and interesting plants are still in pots and boxes, or in nursery rows, for next season's planting.

PLANTS GIVEN TO THE STATION.

From J. S. Calkins, Pomona: Two fuchsias, two camphors, two *Washingtonia filifera* palms, two laurustinus, two *Cupressus macrocarpa*, two *Cupressus pyramidalis*, two *Magnolia grandiflora*, two tea plants, two camellias (seedlings), two *Acacia melanoxylon*, two *Melia Azedarach*, four chestnuts, two *Grevillea robusta*, and garden plants in variety.

SORGHUMS.

A very choice collection of sorghums obtained from various sources was tested, more for fodder and domestic uses than for sugar. There is no reason to believe that any better sugar plant than the beet can be found for the region, though quite a number of Californians are urging sorghum culture for sugar. But the chief value of the sorghums lies in the fact that they yield a very large amount of animal food. Twelve varieties were tested this year at the station. The New Orange bloomed September 5th. It grew six and a half feet high and was stocky. Whiting's sorghum bloomed August 18th and proved the earliest of all. Enyama failed, the seed being old; it is one of the large African sorts. The Duchess Hybrid bloomed September 1st and grew seven feet high; stalks unusually sweet. "No. 42" from the United States Department of Agriculture, grew ten feet high and bloomed early, but the stocks were dry, pithy, and of little or no value. The South African grew eight feet high and was of fair quality. Early Amber, nine feet high, bloomed August 30th. Link's Hybrid bloomed September 15th, reached a height of ten and a half feet, with very stout and strong canes. Folger's Early bloomed September 10th and was eight and a half feet high. Colman's Cane, from Missouri, grew eleven feet high, and bloomed September 28th.

GRAPES PLANTED AT THE POMONA STATION.

Cabernet Sauvignon.
Cabernet franc.
Teinturier mâle.
Meunier.
Sérine.
Petite Syrah.
Mondeuse.
Bastardo.
Cinsaut.
Ploussard.
Carignane.
Petit Bouschet.
Alicante Bouschet.
Aramon.
Etraire de l'Adhui.
Mataro.
Grenache.
Mourastel.
Marsanne.
Ugni blanc.
Bonarda.
Aleatico.
Malvasia bianca.
Mourisco preto.
Tinta de Madeira.
Tinta Amarella.
Tinto Cão.
Boal de Madeira.
Palomino.
Pedro Jimenes.
Verdelho.
West's White Prolific.
Almeria.
Moscato di Alessandria.
Barbarossa.
Thompson's Seedless.
Semillon.
Folle blanche.
Chauché gris.
Verdal.
Burger.
Franken Riesling.
Orleans Reisling.
Gewürz Traminer.
Lagrain.
Bakator rouge.
Slankamenka.
Green Hungarian.
Wälsch Riesling.
Kadarka.
Marzemino.
Blue Portuguese.
Gross blaue.
Refosco.
Nebbiolo fino.
Barbera.
Purple Cornichon.
Black Ferrara.
Black Muscat.
Pizzutello.
Isabella regia.
Diana.
Diamond (white grape).
Martha.
Lenoir.
Cunningham.
Syrian (Palestine).
Luglienga.
Sabalkansky.
Gros Colman.
Sultana (round-berried).

The above plantation has been commenced on the plan of representing all the classes of grapes of southern France, Spain, Portugal, Italy, and the warmer districts generally. The grapes of northern origin are sparingly represented. Some Persian grapes, as elsewhere noted, are being grown for the station; many grapes of Syria have been sent for by the Agricultural Department.

TREES PLANTED AT POMONA.

APPLES.

Amassia.
White Astrachan.
Hoover.
Trenton Early.
Lady.
Perry Russet.
Wealthy.
Hyslop Crab.
Early Ripe.
Alexander.
Jonathan.
Twenty Ounce.
Lawver.
Pewaukee.
W. W. Pearmain.
Montreal Beauty.
Gravenstein.
Arabskoe.
Skinner's Pippin.
Grimes' Golden.
Ortley.
Walbridge.
York Imperial.
Keswick Codlin.
Colvert.
Red Bietigheimer.
Duke of Devonshire.
Missouri Pippin.
Sonoma.
Yellow Bellflower.
Whitney.
Red Astrachan.
Fameuse.
R. I. Greening.
E. Spitzenberg.
Northern Spy.
Stump.
Yellow N. Pippin.
Yellow Siberian.
Sweet Bough.
Reinette de Caux.
Belle de Booskop.
McMahan's White.
Smith's Cider.
Wolf River.
Transcendent.

Pears.

Beurré Giffard.
Beurré Clairgeau.
Beurré Hardy.
Beurré d'Anjou.
Clapp's Favorite.
B. S. Fox.
Frederick Clapp.
Laurence.
Easter Beurré.
Vicar of Winkfield.
Gray Doyenne.
Howell.
Court Queen d'Autumne.
Henry IV.
Iconneau Von Mons.
Jalousie Fontenay Vendée.
Maréchal Vailliant.
Napoleon III.
Eugene Appert.
Louis Vilmorin.
Epine Dumas.
St. Crispin.
Sarah.
Pitmaston's Duchesse d'Angoulême.
Souvenir d'Esperen.
Beurré Golden of Bilboa.
Madame Loisel de Barney.
Princess St. Germain.
Marie Louise d'Uccles.
Baronne de Trello.
Passe Colmar.
Duchesse de Mouchy.
Beurré de l'Assomption.
Duchesse de Bordeaux.
St. Michael Archangel.
Bonne du Puits Ansault.
Brockwell Park.
Duchesse d'Angoulême.
Le Conte.
Bartlett.
Madeleine.
Souvenir du Congrès.
Winter Nelis.
Seckel.
Glout Morçeau.
Beurré Gris d'Hiver.
Lawson.
Dr. Reeder.
Paradise d'Automne.
Doyenne Sieulle.
Augustus Dana.
Jones' Seedling.
Fondante de Noël.
Ott.
Star of Bethlehem.
St. André.
Williams' D'Hiver.
Levard.
Duhamel de Monceau.
Anne Ogereau.
Chaumontel.
Pater Noster.
Theresa.
Duchesse d'Orleans.
Smith's Hybrid.
P. Barry.
Figue d'Alençon.
Napoleon.
Maurice Desportes.
Belle Williams.

Cherries.

Belle Magnifique.
Guigne Tres Précoce.
Rockport Bigarreau.
Centennial.
Olivet.
Early Richmond.
Napoleon Bigarreau.
Black Tartarian.
Willamette.
Tradescant's Blackheart.

Plums.

Bavay's Green Gage.
Coe's Golden Drop.
Duane's Purple.
McLaughlin.
Prince of Wales.
Smith's Orleans.
Washington.
Bradshaw.
Blue Damson.
Ickworth's Imperatrice.
Pré. de Bergthold.
Royal Hâtive.
Yellow Egg.
Jefferson.
Drap d'Or d'Esperen.
Simoni.
Judson.
Satsuma.
Monroe Gage.
St. Lawrence.
Botankio.
Reine Claude Rouge.
Belgian Purple.
Goliath.
Denison's Superb.
General Hand.
Peter's Yellow Gage.
Joe's Autumn.
Long-fruited Japan.
Lucomb's Nonesuch.
Botan.
Czar.
Green Gage.
Perdrignon Blanc.
River's Early Prolific.
Yellow Gage.
Belle de Septembre.
Coe's Late Red.
Early Golden Drop.
Mariana.
Quackenbos.
Victoria.
Ontario.
Wine Sour.
Black Morocco.
Burbank Japan.
Copper.
Red Egg.
Kelsey Japan.
Shropshire Damson.
Lombard.
Bryanstine Gage.
Masu Japan.
Guthrie's Late Green.
Autumn Compote.
New Large Bullace.

PRUNES.

Brignole.
St. Martin's.
Datte de Hongrie.
Wangenheim.
St. Catherine.
Glaister.
Robe de Sergent.
Petite Prune d'Agen.
German.
French.
Silver.
Fellenberg.
Tragedy.
Bulgarian.
Grosse Prune d'Agen.

PEACHES.

Alexander.
Foster.
Nichol's Orange.
Seller's Cling.
Late Crawford.
Ward's Late.
Amsden.
Coolidge's Favorite.
Morris' White.
Runyon's Orange.
Large Early York.
Stump.
Yellow St. John.
California Cling.
Gros Mignon.
Old Mixon Cling.
Heath Cling.
Lovell.
Ford's Improved.
Staley (Cal.) Seedling.
Vineuse.
Early Alfred.
Dagmar.
Pucelle de Malines.
McKevitt's Cling.
Chinese Cling.
Mountain Rose.
Picquet's Late.
Henrietta Cling.
McDevitt's Cling.
Wilkins' Cling.
Briggs' May.
Gov. Garland.
Old Mixon Free.
Susquehanna.
Lemon Cling.
Waterloo.
Blood Cling.
Early Crawford.
Newhall.
Salway.
Late Admirable.
Smock's Late.
Comet.
Muir.
Haines' Early.
Tippecanoe Cling.
Late Morris' White.
Tuscany Yellow Cling.

APRICOTS.

Early Moorpark.
St. Ambroise.
Moorpark.
Turkey.
Sardinian.
Luizet.
Briggs' White.
Pringle.
Newcastle Early.
Early Rivers.
Oullin's Early.
Viard.
DeCoulorge.
Hemskirke.

NECTARINES.

Victoria.
Pitmaston's Orange.
Early Newington.
Downton.
Red Roman.
River's Orange.

ALMONDS.

Commercial.
Languedoc.
Silver Shell.
I X L.
Paper Shell.
Flat-fruited.
Ne Plus Ultra.
Golden State.
Nonpareil.
Drake's Seedling.
Marie Dupuys.
Sultana.
King's Soft Shell.
Pistache.

FIGS.

Agen.
Col di Signor Bianca.
Grizzly Bourjasotte.
Hirta du Japon.
Negro Larga.
Brianzola.
Brogiatto (black).
Rubrado.
Sanvito.
Smyrna.
Dattato (black).
Angelique.
Du Roi.
Gros Grise Bifera.
Monace Bianca.
Ronde Violet Hâtive.
Trojano.
Smyrna (wild).
Dattato (white).
San Piero.
Brogiatto (white).
Giugliono.

Olives.

Amellan.
Atro-violacea.
Lucques.
Manzanillo.
Nevadillo blanco.
Polymorpha.
Præcox.
Regalis.
Salonica.
Huff's Spanish.
Atro-rubens.
Columbella.
Macrocarpa.
Nigerrima.
Oblonga.
Polymorpha (of Sorry).
Pendulina.
Rubra.
Verdale.
Berkeley Seedlings.

Citrus Fruits.

Oranges.

Washington Navel.
Sanguinea.
Pineapple.
Tardiff.
Tangerine (Dancys).
Otaheite.
Konah.
Florida Sour.
Malta Blood.
Jaffa.
Mediterranean Sweet.
Parson Brown.
King.
St. Michaels.
Mandarin.
California Seedlings.

Lemons.

Villa Franca.
Genoa.
Sweet Rind.
California Seedlings.
Sicily.
Eureka.
Lisbon.

Other Citrus Fruits.

Mexican Lime.
"Grape Fruit," of Florida.
Calabria Citron.
Citrus Trifoliata, of Japan.
Shaddock.
Amalfi Citron.
Sorrento Citron.

Japanese Persimmons.

Hachiya.
Funo Kaki.
Yemon.
Memo-gaki.
Yane Nashi.
Lenji Maru.
Hiya Kume.
Giboshi.

Pomegranates.

Sweet-fruited.
Spanish Ruby.
Sub-acid.

Miscellaneous.

Loquat—large-fruited.
Psidium Cattleyanum.
Mulberries in var.
Carob.
Kai Apple.
Kunzea pomifera.

III.

REPORTS

ON

ECONOMIC ENTOMOLOGY AND INSECTICIDES.

School Instruction in Entomology.

Spray and Band Treatment for the Codlin Moth.

Variation in Hessian Fly Injury.

The Use of Gases Against Scale Insects.

REPORTS ON ECONOMIC ENTOMOLOGY AND INSECTICIDES.

SCHOOL INSTRUCTION IN ENTOMOLOGY.

By Edward J. Wickson.

By an Act of the California Legislature, approved March 15, 1887, Section 1665 of the Political Code was amended so as to include "Practical Entomology" among the branches in which instruction must be given in the public schools. This requirement was made by the Legislature at the earnest solicitation of the fruit growers, who claimed that teaching the children to recognize injurious insects, and to understand something of their life-history, would be the most direct and expeditious way to popularize this information, and to overcome the ignorance and carelessness which have always been the best friends of injurious insects and the greatest opponents of progressive horticulture. The idea of the fruit growers in securing this legislation was not alone that the rising generation might yield an increased crop of economic entomologists, which would be a remote benefit; rather was it expected to reap immediate results, because interesting the children in the rudiments of the science would soon spread a knowledge of them abroad throughout the community.

So far as known to the writer, California is the first State of the Union to provide specifically for entomological instruction in the public school. Other States have provision for zoölogy, which might include entomology if the teacher so desired; but in most cases the requirement for zoölogy was reduced to something like "stories about animals." The California requirement cannot thus be parried, because, though the law does not define "Practical Entomology," there is in most rural districts a public sentiment which admits of no misconstruction. This general awakening of the California public on the subject of economic entomology is, at the same time, a warning to the teacher that the law must be complied with, and is a great help to all teachers who make a conscientious effort to do their duty in this respect.

As the subject is so new to our public school teachers, and is by its very nature difficult, there has been a constant appeal to the University for advice and suggestion as to instructional methods and material. The fact that there has been for some time no elementary text-book available made the subject the more appalling to the teacher. The little work by the late Matthew Cooke speedily went out of print, and though the State bought the copyright and plates, no provision was made for the reissue of the work. The possibility of the reappearance of this book as one of the State series of school text-books has probably prevented effort in the same line by private publishers.

In view of the evident need of aid and encouragement to teachers in this new requirement made upon them, I have given considerable time during the last year to such service as I could render in this direction. This has consisted, in part, of attendance at teachers' institutes in a number of counties, and in consultation and correspondence with individual teachers. The grounds taken may be briefly outlined as follows:

1. No satisfactory work can be expected unless the teacher will give the time and application necessary to secure an elementary knowledge of the science and the ability to recognize the chief injurious and beneficial species of the region in which he is teaching.

2. To enable the teacher to do this the school library should contain several elementary and popular treatises on entomology, together with the publications of the University Experiment Stations, the California State Board of Horticulture, and of the Division of Entomology of the United States Department of Agriculture, so far as it is possible to obtain them. The school should also be provided with a number of hand magnifiers, and, wherever possible, with a compound microscope.

3. Much assistance is usually to be obtained by appeal to the County Horticultural Commissioners in counties having such officers. In all fruit-growing neighborhoods there are also well-informed orchardists and vineyardists who have, by necessity, become possessed of considerable knowledge of injurious insects and the methods of repressing them. If the teacher shows willingness and interest, such men and women will assist them greatly in the effort to present the subject to the pupils.

4. It is useless to attempt instruction in entomology by any other than the object lesson. *Instruction should be given with the actual specimens in the hands of the pupil at the time.* This is not only necessary for the correct apprehension of the elements of the science, but it awakens and holds the pupil's interest; it trains his powers of observation and discrimination, and it secures directly the practical results contemplated by those who urged the adoption of the law requiring the instruction, in that the pupil learns to determine the economic character of the insects which come before him.

5. It is not advisable to attempt too much in the way of classification. Entomological classification is exceedingly difficult, because of the vastness and diversity of the insect fauna. If the teacher fortunately has some little knowledge of the subject by previous training, he can readily interest the children in classification up to a certain point. If not, he can, by a little study of books and insects, acquire the ability to classify into orders, and in some cases into families; and he can determine genera and species of the most prominent injurious and beneficial insects by the aid of the State and United States reports. Even if he should shrink from this, but should take pains to know these species at sight, and should learn by book and specimen the transformations, the injury or benefit they work, and the means of destroying the injurious and protecting the beneficial species, he would still be able to deeply interest his pupils and comply with the law.

6. The teacher will find his effort easier and more effective if he invite his pupils to the fullest coöperation; encouraging them to make collections, and to bring their "finds" to the school-room. The teacher should not be afraid to tell the pupils frankly if the specimen is beyond his knowledge. It may even deepen their interest to know that the specimen must be sent to the State University, or elsewhere, to have its standing determined. Let the teacher give a half day on a Saturday to an excursion after insects. Let him take the class to orchards where spraying or other insecticidal warfare is in progress, and ask the orchardist to explain his operation, and the reason for it.

7. In the absence of books suitable for use in grammar grades as text-books, instruction must needs be oral, and in view, also, of the crowded

condition of the grammar school curriculum, it is just as well that such is the case. Oral instruction with specimens is the most direct method of approaching the pupil and of imparting lasting impressions. But oral instruction does not signify that the teacher must prepare a lecture for each lesson, though in presenting some insects it may be desirable to do so. The pupil can recite as well from a specimen before him as from an hour's study of a text-book. More than that, as will be shown in the case of a teacher whose experience will be introduced later, the specimen may be used as a language lesson, as an exercise in free-hand drawing, and otherwise, thus making the most direct compliance with the law, and serve several other useful purposes.

8. The desirability of permanent collections by pupils should not be overlooked. Such collections have in many cases proved the most interesting features of the "last days" of school, and have won free admiration from parents. During the making of such collections, not only the pupils but their parents learn much about insects; and this, as already intimated, is one of the ends aimed at by those who urged the requirement of this study in the schools. Permanent collections of insects, mounted dry, are, however, very perishable under such care as can usually be given them in the school house. A more durable method is to preserve all insects, except butterflies and moths, in small vials filled with three fourths alcohol to one fourth water. Homeopathic vials will contain all save the largest species. If in each tiny vial are put all the forms of the same insect which can be found, and notes made of the plant on or in which each is found, the vial will continually present a condensed life-history of the species, that is, perhaps, inferior to approved museum methods, but has the merit of durability under hard usage or neglect, which museum specimens do not have.

WHAT THE SCHOOLS ARE DOING IN ENTOMOLOGY.

When it appeared that much of my time must be given to the subject under consideration, an effort was made to ascertain how widespread was the effort to comply with the law, and what success was being attained in introducing the subject into the schools. With this in view, letters of inquiry were addressed, in October, 1890, to each County Superintendent of Schools, and to City Superintendents as well. Not all persons addressed replied, but enough responses were received to carry assurance that many are making an honest effort, and that in some cases most gratifying results are being reached. An outline of this correspondence is presented herewith:

Eliza Welsh, County Superintendent, Redding, Shasta County.—Our teachers make but little progress teaching entomology. I think the principal reason for this is that the text-book we use (Cooke's) is not fit for the average country school.

Harriet A. Grover, County Superintendent, Markleeville, Alpine County.—I am very sorry to say that most of our teachers take but little interest in teaching practical entomology.

D. W. Braddock, County Superintendent, Oroville, Butte County.—There is a growing interest taken by the teachers of this county in the subject of practical entomology. For the last two years the subject has been brought before the Teachers' Institute, and there discussed with considerable earnestness, showing that the teachers fully appreciate its importance. A small manual, to be used in conjunction with Cooke's School Entomology, would be a valuable aid to the teacher.

G. B. Lyman, County Superintendent, Yuba City, Sutter County.—Much good work has been done in the line of practical entomology in the public schools of this county, and I think with the present outlook, that we will greatly improve the work in a year or two. The objections to its introduction are seldom hea·d now.

Robert Furlong, County Superintendent, San Rafael, Marin County.—The progress made

since the introduction of practical entomology into the schools of Marin County has not been satisfactory. Encouraging results have been attained in a few schools where teachers, fond of natural history, are at work; but in the greater number of our schools the requirement of the statutes is barely complied with. Marin, as a whole, is not a fruit county, and school patrons object to their children "wasting time studying about bugs." The average school patron looks upon the education of his child from the practical side only. It requires argument to convince him that the child is being educated for the State, instead of a single district or county in which he lives. One enthusiastic teacher lost his position because, as was alleged, "he spent too much time teaching about bugs." However, in some sections of this county, the fruit interests are considerable, and not only the schools but the patrons also are much interested in entomology. Our teachers are educating themselves in this branch. The want of a manual or guide in teaching this subject has been a drawback. Few teachers are sufficiently familiar with the subject to succeed well without a text-book to guide them.

Mrs. F. McG. Martin, County Superintendent, Santa Rosa, Sonoma County.—Our teachers and schools have done most creditable work in practical entomology; many schools have formed valuable collections of insects, and all seem to take special interest in the subject.

L. J. Chipman, County Superintendent, San José, Santa Clara County.—Our teachers are doing very well indeed with entomology, when we take into consideration its difficulty and the want of a first class text-book on the subject.

J. N. Thompson, County Superintendent, Hollister, San Benito County.—The subject of practical entomology being new to many teachers, it has not been as successfully taught in the past as I hope it will be in the future. Some of our teachers are doing excellent work. I find that pupils soon become interested, and take great delight in collecting specimens, in distinguishing the beneficial, and in learning remedies for the injurious.

Job Wood, Jr., County Superintendent, Salinas City, Monterey County.—Our teachers are trying to make the teaching in entomology beneficial. Books are poor, but the insects themselves are furnishing lessons. The powers of observation are being developed, and we hope to see good results.

A. D. Tenny, City Superintendent, Salinas City, Monterey County.—Your communication was handed to the teacher who has charge of the subject of entomology in the grammar grades of our schools, and the inclosed is the statement she has kindly made. I would add that in my own experience I have suffered from lack of books as guides for teaching the subject. I think, too, that there are too many studies required in our public schools, and it would be well to make some provision for omitting, or greatly abridging, some of them, that more time may be given to others.

Belle Duncan, Teacher of Entomology, City Schools, Salinas City, Monterey County.—The classes in entomology use no text-books, but take notes in blank-books. We have in the library a number of the latest works on insects injurious and beneficial to orchards and gardens. We have brought into class infested leaves, branches, and bark, and with small glasses and specimens in the hands of pupils, read from all authors accessible. We are making a solar microscope and heliostat, with which to enlarge upon canvas specimens we have already mounted.

B. F. Howard, County Superintendent, Sacramento.—The study of entomology has not been very vigorously prosecuted in this county. Our course of study requires it in the advanced grade. We have also supplemented that requirement with the following: "Practical instruction should be given in all the grades; special attention should be given to the insects injurious to fruit; bring in specimens of the most common ones and encourage the children to do the same." It is safe to say that many of the schools of the county do not study the subject to any great extent.

W. M. Nuner, County Superintendent, San Andreas, Calaveras County.—I find in my experience that the teachers of this county are very much displeased with entomology, so I cannot give you a favorable letter on the subject.

George F. Mack, County Superintendent, Ione, Amador County.—Our teachers are teaching entomology only in a general manner. It is really a difficult matter to get teachers to take hold of the subject in an earnest way.

A. J. Tiffany, County Superintendent, Nevada City, Nevada County.—Most of the teachers of this county are doing fairly well with the subject of entomology. The text-book is a poor one for practical use, and should be revised; the subject is a new one, and the text-book should be the very best. I am glad to say that all the schools are receiving instruction, and are doing as well as could be expected.

Mrs. W. D. Egenhoff, County Superintendent, Mariposa, Mariposa County.—So little is being done with entomology in the schools of this county that I have nothing of sufficient importance to communicate to warrant entering into details.

Alfred Harrell, County Superintendent, Bakersfield, Kern County.—In my opinion, the introduction of practical entomology into the schools of this county has proved a failure. The term "practical entomology" is a misnomer. The subject receives scant attention, and the work is confined chiefly to the text-book.

J. S. Shannon, County Superintendent, Bishop, Inyo County.—Entomology has been taught with success in some of our schools, yet not as generally as we wish. Many teachers have not taken instruction in that branch, as it is a new requirement, and are not fully prepared to do justice to it. It will grow as a study as our new country grows older. We are not troubled with insect pests as in many other places, hence our pupils do not realize the interest they should take in the matter.

Will S. Monroe, City Superintendent, Pasadena, Los Angeles *County.*—The subject of ento-

mology has received considerable attention in the schools of our city. During the past year insects were studied for several months in the fifth, sixth, and seventh years. Our plan was *a study of typical insects*, and we usually took a week for each subject. We studied only such insects as the pupils themselves could procure. Each pupil was required to have at least one insect. We developed the subject as follows:

First Lesson: Oral language; the pupils examine their insects and make statements of their observations.

Second Lesson: Drawing; insect drawn from the insect.

Third Lesson: Written language; pupils reproduce, in their own language, all they have learned about the insect.

Fourth Lesson: Correction and copying; pupils correct and copy the written lessons.

Fifth Lesson: Dissecting and mounting; pupils dissect the insect studied, and mount it on Bristol board.

In this way we studied beetles, crickets, bees, butterflies, and other insects. Our object in this work was: (1) To train in habits of observation; and (2) to furnish materials for thought expression in the language and drawing. The interest taken in the work, by both pupils and teachers, was marvelous.

This preliminary training paved the way for the more formal study of entomology in the eighth year. Here Cooke's Entomology was introduced. The use of this book has not been satisfactory, and this year we provided for three months' supplementary reading in entomology in the eighth year, using Mrs. Tenny's "Bees, Butterflies, and Other Insects," with admirable results.

If the subject of entomology is to be taught practically, it must be from insects rather than from books. The pupil should be required to study only a *few* insects in *each* of the different orders, and study these few so thoroughly that he may make for himself a comparative study of insects belonging to the same order.

Of the number of City and County Superintendents addressed in the course of this inquiry only about one third replied. The writer is aware, from observation and otherwise, that entomological instruction is being given with satisfactory results in other counties than those named above, and in others, in all probability, it is shunned or neglected. Probably the above showing from one third of those in the interest is a fair representation of the whole. As such, it must be regarded as quite favorable, considering the difficulties which are freely cited by the correspondents, and others which are obvious. It is also clear that the subject is making quite as satisfactory progress as could be expected. The general sentiment of the leading educators of the State toward entomology as a public school study was sharply defined at a general meeting of County Superintendents in Sacramento last winter, when a resolution protesting against the requirement was quickly voted down; and intimation was given in the discussion that those who were disposed to oppose the subject had not made fair trial of it, and consequently did not know to what advantage it could be used. It is fair to expect that this opinion of the majority of those having made fair trial of the subject will prevail even more widely in the future, and that school work in economic entomology will go forward.

ASSISTANT IN ENTOMOLOGY.

The station has been fortunate in securing the services of C. W. Woodworth, M.S., as assistant in entomology. Mr. Woodworth's training as an entomologist, and his work in both the scientific and economic branches of his profession, attest his fitness to extend the efficiency of the station in directions of the greatest importance to California agriculturists.

SPRAY AND BAND TREATMENT FOR THE CODLIN MOTH.

By C. W. Woodworth.

In Bulletin No. 75 of this station Professor Wickson gave, under the above caption, a preliminary account of some experiments conducted under his direction at the University. The following article will present all the results reached by the experiments, and a more exhaustive discussion of the subject:

THE USE OF ARSENITES.

The success reported by Prof. S. A. Forbes, State Entomologist of Illinois, in spraying with Paris green for the destruction of the larvæ as soon as it begins to feed in the calyx of the apple, and similarly good results reported by several California apple growers, suggested that a set of experiments with arsenic and its compounds should be made in the University orchard, where more time could be given to an accurate account of results than a busy fruit grower could devote to such work. As it was known that the late W. G. Klee, then State Inspector of Fruit Pests, was conducting similar experiments on his own farm, and was keeping accounts of experiments by others, it was thought best that the University experiment should be given a direction similar to his, that the results of all experiments could finally be brought together and serve for purposes of a wide generalization. For this purpose Mr. Klee was invited to prescribe the applications to be made. He did so, and assisted personally in the preparation and application of the poisons—a service for which we make due acknowledgment.

Application was made of three substances—white arsenic, Paris green, and London purple—and each in different strengths, as will be specified in the tables which will be given below. The white arsenic was dissolved in hot water; the Paris green and London purple were kept as thoroughly stirred as possible while being drawn up by the pump. The drenching of the trees was quite complete, the spray being especially directed upon the clusters of fruit, which, in most cases, were still upright, so that the drops of the liquid were caught and held in the calyx end. There was, of course, much difference in the size of the fruit, as the orchard comprises a large collection of summer, fall, and winter fruit. Trees were selected, however, as carefully as possible, which had the fruit of the best stage of growth, say from the size of a pea to that of a small marble, at the time of the first spraying.

The tables will show that in most cases three applications were given, all within thirty days from May third. During that period the records of the University Meteorological Observatory show that rain was measured but once, and then but one twentieth of an inch, and in the month of June there was but a sprinkle, even less in amount, so that the weather was perfect for the retention of the poison on the fruit.

The University orchard is planted with two trees of each variety, and in these experiments one was sprayed and the other reserved without treatment, so that a comparison, each tree with one of its own variety and age, could be made. The orchard was guarded in such a way that no outside interference could be had with the fruit. Twice a *week all* the fruit which fell from the sprayed trees and from the check

H.

Fruit.			ted Trees.		Untreated Trees.		Decrease.	
		e l.	Fruit Injured.	Larvæ Found.	Fruit Injured.	Of Larvæ.	Fruit Injured.
	One P						
Pear	Nouveau Poitea	7	8	12	18	5	10
Pear	Nantais	2	2	0	4	—2	2
Apple	Red Canada	3	3	11	27	8	24
	Totals	12	13	23	49	11	36
	One P						
Pear	Duchesse Préco	1	3	4	6	3	3
Pear	Dr. Reeder	1	0	18	10	17	10
Pear	Chaptel	1	5	1	0	0	—5
Apple	Duchess of Old	0	0	0	0	0	0
Apple	Fameuse	0	9	1	4	1	—5
	Totals	3	17	24	20	21	3
	One Pound to 160						
Pear	Buerre Gris d'I	2	3	2	1	0	—2
Apple	Wells' Sweet	1	3	1	1	0	—2
Apple	Duchesse Mign	1	1	4	9	3	8
	Totals	4	7	7	11	3	4
	Totals for Pa	9	37	54	80	35	43
	One I						
Pear	De Tongres†	4	9	8	14	4	5
Pear	St. Michael Ar	1	3	0	0	—1	—3
Apple	Disharoon	4	7	7	2	3	—5
Apple	Yopps' Favori	3	3	3	6	0	3
	Totals	12	22	18	22	6	0
	One						
Pear	Emile de Hey	4	15	5	4	1	—11
Pear	Madame Trey	0	0	11	18	11	18
Pear	Augustus Dan	0	0	2	2	2	2
Apple	Seek No Furth	2	16	25	36	23	20
	Totals	6	31	43	60	37	29
	Totals for Lo	8	53	61	82	43	29
	One Po						
Pear	Callebasse Mo	2	2	3	0	1	—2
Apple	Grimes' Golde	1	1	0	0	—1	—1
	Totals	3	3	3	0	0	—3
	One						
Pear	Ott	0	0	1	0	1	0
Apple	Early Joe	0	0	7	15	7	15
	Totals	0	0	8	15	8	15
	One Poun						
Pear	Napoleon	0	1	0	3	0	2
Apple	Hall	7	23	No	check.	----------	----------
	Totals	7	24	0	3	0	2
	Totals for W	0	27	11	18	8	14
	Grand totals	4	117	126	180	86	86

* *Considerable settlin*

trees, unsprayed, was examined and careful entry made, in a book prepared for the purpose, of all worms found in the fruit, of all fruit from which the worms had escaped, and of the number of worms found under the bands of sackcloth which were placed upon all the trees. This plan of procedure was faithfully carried out until November first, when all the fruit remaining at that time was removed from the trees, examined for worms, and the experiment closed.

The large table herewith shows a summary of the results.

The column headed "Yield" gives the marketable fruit picked from the trees; when the amount was less than a half box per tree it is marked zero. No record was kept of the fallen fruit not affected by the codlin moth.

These applications were all made to affect the first brood of the moth. The figures of infested fruit are all small, for, in Berkeley, as in most places along the coast, at least, the first brood of the moth was unusually small this year. This fact would not necessarily interfere with the percentage of gain by the treatment. In the case of the white arsenic the number of the trees and of worms is too small to give valuable results.

One codlin moth is said to deposit anywhere from fifty to two hundred eggs, and so a single moth, by presence or absence, might produce a great difference in an experiment. When the pest is abundant there is, of course, less danger of such results.

The experiments with Paris green are more satisfactory, as more trees are included, and worms are found on nearly all, which shows that the moth visited the trees more freely. The percentages of gain must be considered very satisfactory, and the stronger applications produce the best results. The application of a wash with one pound of Paris green to one hundred and sixty gallons of water is very satisfactory, giving a decrease of about one half in the number of worms observable, or a saving of two thirds of the fruit which would otherwise have been affected.

The London purple was used too strong, and shows, when estimated by the number of worms actually seen, a decrease much larger than in the Paris green experiments, but only a comparatively small gain when estimated on the basis of the relative amount of injured fruit.

Taking the experiments as a whole, we find, estimating on the basis of the number of worms actually seen, a saving of two thirds, or, according to the amount of injured fruit, a saving of one half. The latter figure is probably nearer correct, and accords well with Eastern experience. It may be put down as established that fully one half of the fruit ordinarily eaten by the codlin moth can be saved by spraying.

EXAMINATION OF THE BAND TREATMENT.

In order to determine some points about the efficacy of banding apple and pear trees for the destruction of the larvæ of the codlin moth, an accurate record has been kept in the University orchard during the past season. The bands were put on early, and consisted of strips of old sacks. The strips were five or six inches wide; the ends were allowed to lap well, and the band was secured by a string tied around near the center, so as to furnish crevices at both the upper and lower edges, to accommodate worms coming from either direction. All these bands were

removed on a certain day each week, the larvæ counted and killed, and the bands replaced. At the same time all the fallen fruit was gathered, examined for worms, or to see if worms had escaped, and records of these facts kept separately. The following table gives a summary of the results:

Results of Band Treatment on Larvæ of Codlin Moth.

	Larvæ Under Bands.	Larvæ in Fruit.	Other Damaged Fruit.	Number Trees in Row.
PEARS—Row No. 9	32	27	76	22
Row No. 10	43	58	141	35
Row No. 11	73	43	130	37
Row No. 12	131	37	178	38
Row No. 13	59	36	117	38
Row No. 14	138	37	235	39
Row No. 15	86	55	237	38
Row No. 16	48	19	100	15
APPLES—Row No. 16	4	1	19	17
Row No. 17	94	50	201	32
Row No. 18	65	19	113	25
Row No. 19	94	89	449	24
Row No. 20	170	70	350	26
Row No. 21	88	45	154	25
Row No. 22	33	23	84	21
Row No. 23	82	32	201	16
Row No. 24	5		8	9
Totals	1,245	641	2,793	457

This summary shows that while two thousand seven hundred and ninety-three apples and pears were found from which worms had escaped, there were found under the bands but one thousand two hundred and forty-five, or 44 per cent; the remaining 56 per cent includes worms which found nesting places elsewhere or perished. The assistant who kept the record of this experiment, assures me that he believes many of these were eaten by birds which were always working over the ground while he was in the orchard. The others must have concealed themselves under clods to spin their cocoons, for there is no loose bark on the trees, and no rubbish or fences in which they could hide.

It is thus seen that less than half the worms are destroyed in this way, and that they are not killed till they have completed their injury to the fruit; still it is not wholly unsatisfactory. Could it be shown that this ratio of destruction was maintained against the first brood, it would probably indicate a large percentage of saving of fruit.

From the nature of the case no definite results as to the saving of fruit through the band treatment can be demonstrated by experiment, and it is generally concluded that except in isolated orchards but little is accomplished except by concerted action of all orchardists in the neighborhood.

OTHER RESULTS FROM THE EXPERIMENTS.

With many insects the use of resistant varieties has proved the most satisfactory, if not the only practical remedy. Wherever there is observable a decided preference, even for one variety of plant over another, good results may be expected. When it is simply a preference, the *planting* of only the varieties that are least preferred will not suffice, but

the use of a few trees of a preferred variety in an orchard of unpreferred fruit will reduce the fight to those few trees. If these are thoroughly poisoned good results should be expected without treating the other trees.

The following lists will show the varieties decidedly below or above the average of injury by the codlin moth, and does not include those whose small yield would make the results especially doubtful.

Of *pears* the following were but little injured:

America.
Ananas d'Eté.
Andrews.
Augustus Dana.
Baronne de Mello.
Belle Lucrative.
Belle Williams.
Beauprésent d'Artois.
Beurré de l'Assomption.
Beurré Golden of Bilboa.
Beurré Précoce.
Beurré Sterkmans.
Bloodgood.
Bonne d'Ezée.
Bonne du Puits Ansault.
Brandywine.
Brockworth Park.
Clapp's Favorite.
Conseiller de la Cour.
Court Queen d'Autumne.
Dana's Hovey.
Dearborn's Seedling.
Doyenne d'Eté.
Doyenne du Comice.
Doyenne Robin.
Doyenne White.
Duchesse d'Angoulême.
Eugène Appert.
Flemish Beauty.
Inconnue Von Mons.
Josephine de Malines.
Louise Bonne de Jersey.
Madame Cuissard.
Madeline.
Manning's Elizabeth.
Marie Louise d'Uccles.
Osband's Summer.
Pater Noster.
Rostiezer.
Rousselet Stuttgart.
Rutter.
Seckel.
St. André.
Star of Bethlehem.
St. Crispin.
St. Michael Archangel.
Tyson.
Urbaniste.
Washington.

The following showed more than the average injury:

Bartlett.
Bergamotte Cadet.
Bergamotte d'Esperen.
Beurré d'Aremberg.
Beurré Diel.
Beurré Goubalt.
Beurré Langeier.
Bezi Sanspareil.
De Tongress.
Doyenne Boussock.
Doyenne Sieulle.
Duchesse de Mouchy.
Duchesse d'Orleans.
Edmonds.
Epine Dumas.
Jaminette.
Lawrence.
Maurice Desportes.
Napoleon the Third.
Nantais.
Oswego Beurré.
Stevens' Genesee.
St. Germain.
Swan's Orange.
Williams' D'Hiver.

Of *apples* the following were not much injured:

Count Orloff.
Garretson's Early.
Gravenstein.
Hall.
Pomme Royale.
Primate.
Summer Queen.
Sweet June.

Those that were much injured are:

Berry.
Golden Sweet.
Maverick Sweet.
Ortley.
Roxbury.
Russet.

No attempt has been made to follow out the life-history of the codlin moth in this particular region. It is a well known fact that the number of broods vary in different regions. It is probable that in a climate as warm as this there is hardly any such thing as broods in the ordinary use of the term. All sizes may be seen at any time in the fall, and for spray treatment application must be made later on the winter fruit than on the summer or fall varieties to destroy the later worms. The following table will show the varying amount of injury:

Season Result of the Spray Treatment.

SEASON.	Number of Trees.	Larvæ per Tree.	Injured Fruit per Tree.
PEARS—Summer	18	7.61	8.76
Fall	37	6.62	10.46
Winter	38	11.10	18.91
With small yield	47	1.97	3.18
APPLES—Fall	8	1.12	1.78
Winter	21	16.42	38.41
With small yield	92	6.42	10.85

The varieties which gave too small a yield to give reliable results were all put together, instead of in their proper classes. It will be seen that the injury to winter fruit greatly exceeded that to summer and fall fruit.

VARIATION IN HESSIAN FLY INJURY.

By C. W. WOODWORTH.

The appearance of the Hessian fly in the experimental plots in 1885, in such numbers as to vitiate the culture and fertilizer experiments then under way, gave opportunity the following year of making a test of the relation between the variety of the grain and the injury by Hessian fly under conditions very favorable to such experimentation. The results obtained in 1886 were published in Bulletin 58 of the Experiment Station, and more fully in the report for 1887. These observations were repeated in 1887, 1889, and in 1891, and it is thought that the confirmatory evidence thus obtained make the results of considerable value.

The University grounds are quite isolated from other fields in which grain is grown, and but for that sown for hay, there would be hardly a possible chance of infection from without. Wheat had been grown on the grounds for several years, but the fly had only appeared in such destructive numbers the year before these experiments began. The same field was used in 1886, 1887, and 1889, the dates of sowing being February 24 and 25, 1886; a few were sown January 18, 1887, but most of them on the twenty-fourth; and in 1889 they were all sown the second of February. Not planting in 1888 did not seem to have any effect on the flies; but from this cause or some other, they were almost completely exterminated this year, for careful search, even in the most susceptible varieties, showed but very few "flax seeds."

The following table will show the observations on wheat, made during the three years that the fly was abundant:

OBSERVATIONS ON INJURY TO WHEAT BY THE HESSIAN FLY IN 1886, 1887, AND 1889.

Variety.	1886.			1887.			1889.		
	Crop.	Harvest.	Flies.	Crop.	Harvest.	Flies.	Crop.	Harvest.	Flies.
Archer's Prolific	Poor		Few	Fair	July 15	Abundant.	Very poor.	July 15	Abundant.
Arizona Indian seed	Failure	July 28		Poor	July 8	Abundant.	Poor	July 15	Abundant.
Arnold's Gold Medal	Failure		Abundant.	Poor	July 8	Abundant.	Failure		
Austrian	Poor	July 28	Abundant.	Fair	July 28	Abundant.	Very poor.	Aug. 7	Abundant.
Bearded Macaroni	Fair	July 19	Few	Poor	July 11	None			
Bearded wheat from Missoyen	Poor	July 19	None	Good	July 16	None	Fair	July 25	Very few.
Beardless Velvet	Failure		Abundant.						
Big Long-bearded Club	Fair	July 19	Few	Failure			Fair	July 25	Very few.
Big White Club	Very poor.	July 28	Abundant.				Poor	July 25	Abundant.
Big White Club (Oregon)	Poor	July 28	Abundant.	Good	July 15	Few	Fair	July 15	Few.
Black Bearded Centennial	Failure			Good	July 28	Abundant.	Very poor.	Aug. 17	Abundant.
Black Bearded Spelt				Fair	July 28				
Black Emmer Spelt	Failure								
Blood Red	Failure			Poor	Aug. 3	Abundant.	Failure		
Blue Bearded (Brenner)				Failure			Failure		
Blue Bearded Spelt	Fair	July 28	Abundant.	Fair	July 28				
Blue Glass	Fair	July 19	Very few	Very poor.	July 21	None	Fair	July 2	Very few.
Bohemian	Failure			Poor	Aug.	Abundant.	Failure		
Brown Bearded	Failure			Failure			Failure		
Brown Spelt	Failure		Abundant.						
California Spring	Poor	July 19	Abundant.	Poor	July 21	Abundant.	Poor	July 25	Abundant.
Champlain	Poor	July 19	Abundant.	Poor	July 25	Abundant.	Poor	July 31	Abundant.
Chiddam	Failure			Poor		Abundant.	Very poor.		Abundant.
Chile	Very poor.	July 28	Abundant.	Failure			Failure		
Clawson	Very poor.	July 28	Abundant.	Failure			Poor	July 29	Abundant.
Common March	Fair	July 19	Very few	Good	July 15	None	Fair	July 16	Very few.
Common White Bearded Spelt	Fair	July 19	Abundant.						
Cujavian	Failure			Failure			Poor	July 29	Abundant.
Defiance				Fair	July 21	Abundant.	Poor	Aug. 1	Abundant.
Diamond				Good	July 15	None	Fair	July 17	Very few.
Diehl's Mediterranean	Failure			Fair	Aug. 3	Few			
Dinkel Spelt	Poor	July 28	Abundant.						
Egyptian	Failure	July 28	Few	Good	July 15	Few			Very few.
Egyptian Imported		July 19		Poor	July 11	None	Fair	July 20	Very few.
Emmer		July 28	Few	Good	July 15	Very few	Poor	July 29	Few.
Extra Early Oakley				Good	July 15	None	Poor	July 29	Abundant.
Fern, or April	Fair	July 28	Few	Poor	July 21	Abundant.	Poor	July 29	Abundant.

OBSERVATIONS ON INJURY TO WHEAT BY THE HESSIAN FLY—Continued.

VARIETY.	1886.			1887.			1889.		
	Crop.	Harvest.	Flies.	Crop.	Harvest.	Flies.	Crop.	Harvest.	Flies.
F. Gates				Poor	July 8	Abundant.	Poor	July 15	Few.
Forell	Fair	July 28	None	Fair	July 21	None	Fair	July 15	Very few.
Four-rowed Sheriff				Poor	Aug.	Abundant.	Failure		
Frankenstein	Poor	July 28	Few	Fair	July 21	Abundant.	Fair	July 25	Few.
Fultz	Failure	July 28	Few	Good	July 15	Abundant.	Poor	July 14	Abundant.
Genoese Winter	Fair	July 28	Few	Good	July 11	Very few	Fair	July 29	Few.
Ghurka, or Odessa	Very poor.	July 28	Abundant.	Good	July 16	Very few	Fair	July 29	Few.
Golden Drop	Failure			Poor	Aug. 3	Abundant.	Failure		
Greek Atlanti				Good	July 18	Very few	Fair	July 24	Few.
Hallet's Genealogical	Failure			Poor	Aug. 3	Abundant.	Failure		Abundant.
Hallet's Original Red	Failure			Poor	Aug. 3	Abundant.			Abundant.
Hallet's Pedigree of White Victoria				Poor	Aug. 3	Abundant.	Very poor.	Aug. 17	Abundant.
Hungarian (Brenner)	Poor	July 28	Few	Fair	July 28	Abundant.	Very poor.	Aug. 7	Abundant.
Hungarian (Burke)	Poor	July 28	Few	Failure					
Hungarian (Mountain)	Fair	July 19	Few	Fair	July 18	Abundant.	Poor	July 31	Abundant.
Hunter's White				Good	July 18	Few	Fair	July 31	Very few.
Improved Circassian	Fair	July 19	Few	Good	July 21	Few	Fair	July 29	Very few.
Indian White Winter	Very poor.	July 28	Abundant.	Poor	July 3	Abundant.	Fair	July 25	Few.
Jonquil	Poor	July 28	Abundant.	Poor	July 18	Abundant.	Failure		
Little Club	Poor	July 19	Abundant.	Good	July 11	Few	Failure		
McGehee's White	Failure		Abundant.	Good	July 21	None	Very poor.	Aug. 17	Abundant.
Mammoth	Very poor.	July 28	Abundant.	Good	July 21	Few	Poor	July 25	Few.
Manchester				Failure			Very poor.	July 31	Abundant.
Martin's Amber	Failure				Aug. 15	Abundant.	Failure		Abundant.
Michigan Mixed	Poor	July 28	Abundant.	Good	July 21	Few	Poor	Aug. 7	Abundant.
Mold's Red Winter	Failure			Poor	July 3	Abundant.	Failure		Abundant.
Mold's White	Failure			Poor	July 15	Abundant.	Failure		Abundant.
Nicaragua				Good	July 11	Few	Good	July 15	Very few.
Nonette Lausanne	Fair	July 19	Very few	Good	July 8	Few	Good	July 20	Very few.
Nonpareil	Poor	July 22	Few	Fair	July 18	Abundant.	Fair	July 25	Few.
North Allerton	Failure			Poor	July 3	Abundant.	Failure		Abundant.
Paine's Defiance	Failure			Poor	July 3	Abundant.	Failure		
Palestine	Fair	July 13	None	Good	July 6	None	Fair	July 16	Very few.
Patent Office				Failure			Very poor.	July 29	Abundant.
Petali	Fair	July 13	None	Good	July 6	None	Fair	July 16	Very few.
Polish	Fair	July 19	Few	Good	July 16	None		July 20	Very few.
Prince Albert	Failure			Poor	July 3	Abundant.			

Pringle's Best	Poor	July 28	Abundant	Fair	July 21	Abundant	Fair	July 25	Very few.
Pringle's Defiance	Very poor	July 28	Abundant						
Probsteier	Failure			Failure			Failure		
Proper				Poor	July 16	Abundant	Very poor	July 29	Abundant.
Propo				Fair	July 11	Abundant	Poor	July 16	Few.
Raub's Black Prolific				Good	July 15	None	Failure		
Red Bearded	Fair	July 12	Few	Poor	July 11	Abundant	Poor	July 17	Abundant.
Red Chaff	Poor	July 28	Abundant	Fair	July 18	Abundant	Poor	July 31	Abundant.
Red Club, or Hedgehog	Fair	July 19	Few	Good	July 16	Few	Poor	July 25	Few.
Red Emmer Spelt	Poor	July 19	Few	Fair	July 25				
Red Llama				Failure			Failure		
Red Sea	Poor		Abundant	Good	July 11	Abundant	Failure		
Red Sonora	Fair	July 13	Few	Poor	July 11	Abundant	Poor	July 17	Abundant.
Royal Australian	Poor	July 28	Abundant	Fair	July 11	Abundant	Poor	July 17	Abundant.
Russian Red Bearded				Good	July 18	Few		July 20	Few.
Rust Proof Indian				Fair	July 8	Abundant	Fair	July 15	Few.
Rye Wheat	Fair	July 28	Few	Fair	July 21	Abundant	Failure		
Short-bearded Club	Failure			Failure			Failure		
Siberian				Poor	July 28	Abundant	Failure		
Sicilian	Failure		Abundant	Poor	July 28	Abundant	Poor	July 20	Abundant.
Sicila (Brenner)				Failure			Failure		
Smoggi	Failure			Poor	July 15	Abundant	Failure		
Snowflake				Fair	July 21	Abundant	Poor	July 29	Few.
Square Sicilian	Very poor	July 13	Abundant	Fair	July 15	Abundant	Failure		
Taganrog		July 14	None	Good	July 11	Abundant	Fair	July 15	Few.
Thuringian	Poor	July 28	Abundant	Fair	July 28	Abundant	Poor	Aug. 7	Few.
Touzelle	Very poor	July 28	Abundant	Poor	July 28	Abundant	Poor	July 25	Abundant.
Tunisian	Failure	July 28	Abundant	Good	July 18	Few	Poor	July 7	Few.
Velvet Bearded	Failure			Failure					
Velvet Club				Failure			Failure		
Victor	Poor	July 19	Few	Fair	July 3	Abundant	Poor	July 25	Abundant.
Victoria	Poor	July 19	None	Good	July 21	None	Fair	Aug. 7	Few.
Volo	Good	July 12	None	Good	July 15	None	Fair	July 15	None.
Washington Glass	Very poor		None	Poor	Aug. 15	None	Failure		
White Banater	Very poor	July 19	Abundant	Good	July 25	Abundant	Poor	Aug. 2	Abundant.
White Bearded Spelt	Fair	July 28	Few	Fair	July 25				
White Club				Poor	July 15	None	Poor	July 25	Few.
White Crimea				Good	July 11	None	Poor	July 25	Abundant.
White Essex	Failure			Fair	July 28	Abundant	Failure		
White Flanders	Failure			Fair	July 15	Abundant	Failure		
White Glass				Failure			Failure		
White Llama	Failure			Fair	July 3	Abundant	Very poor	July 24	Abundant.
White Pearl	Failure			Failure			Failure		
White Russian	Failure			Fair	July 3	Abundant	Poor	July 24	Abundant.
White Sonora	Failure	July 28		Failure			Failure		

OBSERVATIONS ON INJURY TO WHEAT BY THE HESSIAN FLY—Continued.

VARIETY.	1886.			1887.			1888.		
	Crop.	Harvest.	Flies.	Crop.	Harvest.	Flies.	Crop.	Harvest.	Flies.
White Velvet	Failure			Failure			Poor	July 25	Abundant.
Whittington	Poor	July 13	Few	Fair	July 8	Abundant	Poor	July 25	Abundant.
Winter Eagle				Poor	July 25	Abundant.	Failure		
Winter Fulcaster				Good	July 25	None	Poor	Aug. 17	Abundant.
Winter (Rickenbrode)	Failure		Abundant:	Poor	July 15	Abundant.	Failure		
Yellow Noé	Poor	July 19	Abundant.	Fair	July 25	Abundant.	Poor	Aug. 7	Few.

RESISTANT VARIETIES.

Volo and Washington Glass are the only varieties that have remained free from the Hessian fly. The latter, however, never yields well with us. Several other varieties have a very good record. Especially free from the fly are the following:

Bearded Wheat from Missoyen.	Polish.	Diamond.
Forelle.	Blue Glass.	Egyptian Imported.
Palestine.	Common March.	

The following varieties have had more or less fly, but never in abundance:

Bearded Macaroni.	Greek Atlanti.	Nonette Lausanne.
Big Long-bearded Club.	Hunter's White.	Red Club.
Egyptian.	Improved Circassian.	Russian Red Bearded.
Genoese Winter.	Nicaragua.	White Club.

EARLY AND LATE VARIETIES.

One hundred observations on early and the same number on late varieties were selected from the large table above to compare their relation to Hessian fly injury. Of the one hundred early varieties only forty-five were badly infested, against sixty-seven of the late, an advantage for the early varieties of over 20 per cent. The following table will give the data in more detail:

Flies.	1886.		1887.		1889.		Totals.	
	Early—Per Cent.	Late—Per Cent.	Early—Per Cent.	Late—Per Cent.	Early—Per Cent.	Late—Per Cent.	Early—Per Cent.	Late—Per Cent.
None	18.3	3.3	23.0	13.8	4.0	0.0	17.0	7.0
Very few	11.0	0.0	6.2	2.3	32.0	7.0	14.0	3.0
Few	41.4	31.3	12.3	16.1	28.0	25.0	24.0	23.0
Abundant	29.3	66.4	58.5	66.8	36.0	68.0	45.0	67.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Comparing the same varieties on the basis of the yield, we get similar results; 60 per cent of the early varieties give fair or good crops in spite of the flies, while only 37 per cent of the late varieties do so. Below are the figures in detail:

Crop.	1886.		1887.		1889.		Totals.	
	Early—Per Cent.	Late—Per Cent.	Early—Per Cent.	Late—Per Cent.	Early—Per Cent.	Late—Per Cent.	Early—Per Cent.	Late—Per Cent.
Failure	0.0	10.3	0.0	0.0	0.0	0.0	0.0	3.0
Very poor	7.4	27.7	0.0	2.4	8.0	28.0	4.0	17.0
Poor	37.0	41.3	33.0	34.9	20.0	15.0	36.0	43.0
Fair	51.9	20.7	23.0	37.2	48.0	5.0	37.0	26.0
Good	3.7	0.0	44.0	25.5	4.0	0.0	23.0	11.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

THE DATE OF PLANTING.

To settle the question of the best date for planting, it would be best if there were extensive parallel sets of experiments, but as there was considerable difference in date of planting in the different years, the results may be of some significance. The table below shows the average date of harvest, of planting, and the length of season of the three years:

Year.	Average Date of Planting.	Average Date of Harvest.	Average Length of Season.
1886	February 24	July 23	149 days.
1887	January 23	July 16	174 days.
1889	February 2	July 25	173 days.

The years 1887 and 1889 required practically the same length of time to mature the grain, and were only ten days apart in time of planting; but it is not these two years, but 1886 and 1889, that show parallel, whether measured by the crop or by the abundance of the flies, as the following tables will show:

Crop.	1886.	1887.	1889.
Failure	40 per cent	18 per cent	33 per cent.
Very poor	11 per cent	1 per cent	11 per cent.
Poor	26 per cent	29 per cent	33 per cent.
Fair	22 per cent	25 per cent	21 per cent.
Good	1 per cent	27 per cent	2 per cent.
	100 per cent	100 per cent	100 per cent.

Flies.	1886.	1887.	1889.
None	11 per cent	20 per cent	1 per cent.
Very few	6 per cent	4 per cent	21 per cent.
Few	33 per cent	14 per cent	27 per cent.
Abundant	50 per cent	62 per cent	51 per cent.
	100 per cent	100 per cent	100 per cent.

The conclusion to be drawn is that though there may be a decided difference between early and late sowing on a particular year, this difference is due to the peculiar conditions existing on that year; that early planting may be best on one year and late planting on another, and that no rule can be laid down.

In connection with these data it might be added that the crop of 1891, which was so peculiarly free from the Hessian fly, was planted much earlier than either of these years, being the tenth of November, 1890.

THE USE OF GASES AGAINST SCALE INSECTS.

By F. W. Morse.

[In the spring of 1887 the Agricultural Department of the University was requested by Messrs. A. B. and A. S. Chapman, Mr. L. H. Titus, and Mr. J. C. Newton, prominent orange growers of Los Angeles County, to conduct experiments with the view of determining the efficacy of certain gases as insecticides—with special reference to the white scale, *Icerya Purchasi*. The work was intrusted to F. W. Morse, at that time in charge of the Agricultural Laboratory, who carried on his investigations and experiments in the orange orchards at San Gabriel and published his results and conclusions in University Bulletins, viz.: Bulletin 71, June 12, 1887; Bulletin 73, August 27, 1887; Bulletin 79, May 5, 1888. Recent progress in the practical application of insecticidal gases has made it unnecessary to reproduce some of these early investigations. There were, however, certain points of the work of wide and permanent interest, and they are collated from the writings of Mr. Morse, as follows:]

The use of gases against scale insects has been long contemplated, and various appliances have been suggested for the ready application of any efficacious gas. The ease with which gas penetrates to all parts of the tree naturally suggests its use as preferable to washes, which at best leave many parts of the foliage and infested branches untouched, even when sprayed with the greatest care. In order that the gas may be an efficient insecticide, it must be so poisonous that even when applied in small quantities it produces fatal results, for in the application the air confined in the tent covering the tree dilutes the gas to a great extent. Again, the gas must be capable of being generated quickly in sufficient volume. The record below shows that any one of the gases fulfilled these conditions to a satisfactory extent. Preliminary experiments with some others having shown their unfitness for the purpose, either on account of expense or because of injury to the foliage, or imperfect action on the insects, their study was not pursued further.

GASES EXPERIMENTED WITH.

Among the gases used were chlorine, sulphuretted hydrogen, ammonia, carbon bisulphide, carbon monoxide, carbonic acid, hydrocyanic acid, and carbolic acid vaporized by heat.

Chlorine.—Some preliminary experiments were made in small vessels into which this gas had been introduced. Some infested branches were allowed to remain in them for times varying from five to thirty-five minutes, without any noticeable effect being produced on the insect. Atmospheres more strongly saturated with the gas proved fatal to the insect in a short time. In other treatments extending over eighteen hours, with less saturated atmospheres, only a small percentage of the insects were killed. No decided effects were noticeable on the foliage unless the gas was very concentrated.

Carbon Bisulphide.—A lime tree twelve feet in diameter at the top, was treated with the vapor of two and one half pounds of sulphide of carbon for forty-five minutes. At the end of this time the insects were lively, and during the treatment had crawled up and collected around

a rope surrounding the tree, at the point where the gas was being injected from the hose. It proved that the gas thus used injures neither the insects nor the foliage. It is upon record, however, that in cases where the vapor has not been thoroughly diffused, but was allowed to flow down from an open vessel placed in the top of the tent, serious injury was done to the foliage at points where the undiluted vapor flowed down.

Sulphuretted Hydrogen.—Several treatments with this gas were made on a small scale, the application lasting from five to thirty-five minutes. The effects produced either with diluted or concentrated gas were similar to those produced by chlorine, except that even the concentrated sulphuretted hydrogen did not injuriously affect the foliage. An experiment in which a whole tree was treated in the tent for forty-five minutes, with quite concentrated sulphuretted hydrogen gas, showed clearly that the effect was far from being satisfactory; the insects for the moment were stupefied, but in the course of an hour and a half the majority of them were again moving about.

Ammonia.—The vapor from one pound and a half of strong ammonia water was applied to an eleven-foot lime tree for thirty minutes. The results were disastrous to the foliage; the leaves were all scalded, and in a few days all dropped from the tree, and even the newer growth of wood was injured. The insects, however, were not perceptibly harmed.

Carbon Monoxide.—Very strong hopes have been entertained by many for the successful application of this gas. Its apparent cheapness and easy production, when the necessary plant is once erected, would recommend it. Unfortunately our experiments show that it is not sufficiently effective to warrant its use. The gas was obtained by forcing air through a small furnace filled with red-hot charcoal, care being taken to cool and to measure the gas before applying it. No appreciable effect was noticeable after forty minutes. In a duplicate experiment, in which the charcoal was more strongly ignited and continuously introduced into the barrel for thirty minutes, only slightly better results were obtained.

Oxalic Acid.—It was thought that the production of carbon monoxide by decomposition of oxalic acid by heat, might be substituted for the previous method of generating this gas. One quarter of a pound of oxalic acid was ignited and the gases applied in a manner similar to that of the preceding experiment. Neither the insects nor the foliage was harmed in the least. This experiment has incidentally shown that the vapor of formic and oxalic acids, also produced during the heating of the latter, is likewise ineffective.

Carbolic Acid.—It has been suggested that carbolic acid vaporized by heat would prove fatal to the insect. A dose of half a pound of liquid acid was volatilized in the furnace, and the vapor blown into the vessel containing the infected branch. At the end of twenty minutes all the old insects were still alive, and some of the young ones, just molted, were moving about. An hour later the foliage appeared as if scalded.

Hydrocyanic Acid.—It was only with hydrocyanic, or prussic acid (generated by the action of sulphuric acid on potassium cyanide), that sufficiently fatal effects were secured to warrant a more thorough determination of the time of exposure and quantities of material which would produce the best results. Numerous experiments were carried on for this purpose, and it was shown that even small amounts were

effective. It was also shown that even in these small quantities an injurious effect upon the foliage was produced. In the beginning of the experiments "mining cyanide" of potassium was used. It is a very impure material, and contains, along with the cyanide, a considerable amount of carbonate of potassium. For this reason many of the first treatments were practically ineffective.

Later treatments with pure cyanide were more successful in destroying the insects, but the foliage was proportionally injured. Treatments, varying in dose from four to twelve ounces of cyanide, and in time from fifteen to sixty minutes, showed that the effect produced on the foliage by longer treatment was not proportionally greater than that produced by short treatment. Neither was the effect of longer treatments proportionally more fatal to the insects. It was thus clearly shown that the gas mixture should be of considerable strength in order to secure rapid action.

The effect of the gas was so disastrous to the foliage that it became necessary to find some means of remedying this trouble. This was sought in applying a second gas, which might preserve the foliage. Sulphuretted hydrogen was therefore injected into the tent, together with the cyanide gas, both from the same generator, a portion of the sulphuretted hydrogen being introduced before the cyanide was generated. It was found that the insects appeared stupefied when the tent was raised, but large numbers revived in a few hours. The effect of the cyanide seemed therefore to have been decreased by the sulphuretted hydrogen. The foliage was not preserved, although not so badly affected as by treatments with cyanide alone.

Carbonic acid gas was next tried. Trees were treated with larger doses of cyanide than heretofore used, and the carbonic gas from one and one half pounds of carbonate of soda was at the same time introduced with these doses. The insects were killed, and the foliage of a twelve-foot tree remained unharmed, while that of a fourteen-foot tree, with the same amount of carbonic acid, was slightly injured. Thus it was shown that it would require one and one half pounds of bicarbonate of soda to preserve tree tops twelve feet in diameter, and that with this protection the deadly cyanide could be successfully used.

INJURY TO FOLIAGE.

It was plainly noticeable that under the influence of the direct sunshine much more burning took place. Trees which were treated in the forenoon of hot days, were burned mostly on the east side, and this injury to the foliage appeared always upon the side of the tree which was exposed to the sun at the time of the treatment. The injury was undoubtedly done while the tent was upon the tree, and did not result from burning after the tent was removed.

Trees which were treated early in the morning or late in the afternoon remained perfectly unharmed. In one case the temperature in the shade was about 92 degrees, while within and close to the sunny side of the tent the temperature reached 108 and 110 degrees.

This injury to the tree may be lessened somewhat by covering the frame with a cloth which will shade the tent; but it will be found more convenient to make the treatments with the gas in cooler seasons of the year, or in the cooler hours of the day. When injured by exposure to

sun heat the leaves drop off, but without injury to the green, woody stems. Fresh shoots have appeared in the course of three weeks after the treatment.

The prospects of effective treatment of scale insects by this method are quite promising. The gas is not only deadly to the insects, but kills also the eggs, notwithstanding they are confined in the cottony cushion sac of the insect. The effect of the gas is equally deadly to the white as to the black and red scales.

It must not be understood that these experiments definitely settle the mode of operation and the size of the doses to be used. They are merely suggestive of a general plan which can be so perfected in the future that the application of this remedy to other kinds of trees and insects must be attended with good results. It simply remains for the ingenious cultivator to devise the necessary appliances for its use, on a small scale, on all sorts of fruit trees, shrubs, and plants.

It must not be forgotten that extreme care in the handling, both of this deadly gas and of the cyanide itself, is necessary. To inhale the one, or to taste or touch a wound with the other, may lead to serious consequences.

EXPERIMENTS ON THE CAUSE AND AVOIDANCE OF INJURY TO FOLIAGE IN THE HYDROCYANIC GAS TREATMENT OF TREES.

The investigations here recorded were made from time to time during November, December, and January of 1887–88, in order to find out what caused the injury, and likewise to explain the protective action of the carbonic acid used in the later experiments. The general manner of treatment, as applied on a large scale, was followed in each operation,* and suitable apparatus was devised for carrying on the details.

A barrel of about five cubic feet capacity was used as a chamber to replace the tent. A small bellows was used to produce the necessary circulation, and a glass bottle, into which was inserted a closed funnel holding the proper doses, served as a generator.

A small Woulff's (three-necked) bottle served the purpose of a "relay," where the gases could be mixed, or material for drying them inserted. The temperature was indicated by thermometers placed in the top of the chamber.

A half dozen orange branches set in pots, and a dozen well-potted orange seedlings were used to experiment upon. The former were used to obtain some preliminary measure of the quantity of materials to be employed in the later treatments.

* It should be noted that an essential point in the mode of operating, first practiced by me at San Gabriel in the spring and summer of 1887, was the use, at the suggestion of Professor Hilgard, of a pump or blower for the purpose of mixing the gases generated, with the air in the tent, by continuous circulation, thus avoiding injury from the effects of overdoses at some points, while leaving others without adequate treatment, as must inevitably happen where no such equalizing appliance is used. It was doubtless from this cause that experiments previously made by others (understood to have employed hydrocyanic gas) were not satisfactory.

Table Showing the Arrangement of the Several Experiments; Numbered for Reference.

No. of Exp't.	Materials Used.	Method of Treatment.	Temperature—Deg. Fahrenheit.	Remarks.
1	Not treated			
2	Cyanide	Wet	60	
3	Cyanide+Carbonate	Wet	59	
4	Cyanide	Dry	58	
5	Cyanide+Carbonate	Dry	59	
6	Cyanide	Wet	58	
7	Cyanide	Wet	59	
8	Cyanide+Carbonate	Wet	59	
9	Cyanide	Dry	66	
10	Cyanide+Carbonate	Dry	67	
11	Cyanide	Wet	64	Sprayed.
12	Cyanide+Carbonate	Wet	63	Sprayed.
13	Cyanide	Wet	100	
14	Cyanide+Carbonate	Wet	103	
15	Cyanide	Dry	109	
16	Cyanide+Carbonate	Dry	106	
17	Cyanide	Wet	102	Sprayed.
18	Cyanide+Carbonate	Wet	97	Sprayed.
19	Ammonia determination			
20	Cyanide	Dry	59	
21	Cyanide	Dry	55	
22	Cyanide	Wet	54	
23	Cyanide	Wet	56	
24	Cyanide	Wet	56	
25	Cyanide	Wet	56	Gas dried.
26	Cyanide	Wet	63	
27	Cyanide—Ammonia	Wet	55	
28	Cyanide—Ammonia	Wet	67	
29	Cyanide—Ammonia	Wet	62	Mixed in chamber.
30	Formic acid—Ammonia		59	
31	Formic acid		53	

The second column shows the materials employed; the third indicates whether they were used in the solid condition (dry) or in solution (wet).

When operating in the "dry" way the salts were used in the solid form, and usually the gas was further dried and freed from ammonia by passing it through strong sulphuric acid. In operating in the "wet" way, *solutions* of the salts were used, and the gas was passed directly into the chamber, except in one or two cases, where the gas was subsequently dried. The fourth column indicates the temperature at which the air in the chamber was kept.

In No. 1 an orange limb was used, potted like the others, and left untreated, to serve as a check. It remained in good condition throughout the time of experimenting.

In the numbers following, the conditions were varied both by changing the manner of treatment and materials used. The doses used were larger in proportion than those used in the field-work, in which it was shown that small trees required proportionally larger doses than large ones.

In several cases the trees and the inside of the chamber were sprayed with water, to note the effect of the gas upon wet trees, and also to note that of water upon the gases themselves.

PRODUCTION AND EFFECTS OF AMMONIA.

It is known that when *cyanates* are present in generating hydrocyanic gas, more or less *ammonia* is produced. In the materials used for these experiments this may have been the case. Furthermore, under certain conditions, ammonia may be produced in the treatment of simple cyanide with acid. Preliminary tests were made to demonstrate these facts, and to study the reactions when applied in various ways, as well as to determine the best mode of using the materials. For the intense scalding effects of ammonia upon the foliage had been noted in my former experiments, and it was conjectured that this gas, unintentionally produced, might be concerned in causing injury in cases not otherwise easily explained.

As previously reported, it was found impracticable to use the cyanide of potassium without first dissolving it, and that it was necessary to keep the carbonate of soda well mixed with the cyanide, so that the reaction upon both would occur at the same time. But it was further shown that the alkaline reaction of the gas, due to ammonia, is produced only when the solution, instead of the solid cyanide, is used; *rapid* addition of the acid to the dry salt, or *vice versa*, invariably produced an *acid* gas, while the *slow* mixing of the two materials in solution invariably produced decided *alkalinity*, often to a very harmful degree. The amount of ammonia was found to be variable, perhaps largely because a part was masked by the hydrocyanic acid produced during the violent action that takes place when the acid is added rapidly to the solution.

All the experiments with the dry cyanide alone showed but slight injury to the foliage, and a slight increased injury was noted on the plants treated with the cyanide *solution* alone. When the carbonate of soda was used with the cyanide in the solid form or in solution, the injury to foliage was in either case very materially lessened. Passing the gas through sulphuric acid produced results similar to those of the carbonate treatment, viz.: immunity to the foliage.

Indications have thus pointed toward ammonia as the cause of the injury—some direct experiments were made with this gas. In the first ammonia treatment the gas was separately generated and mixed with the hydrocyanic gas from an ordinary treatment, the mixed gases being conducted into the chamber.

The intensely acid action of the gas leaving the hydrocyanic generator at once turned to the alkaline, and so continued in the chamber, thus showing that a certain moderate excess of ammonia was present. Decidedly injurious effects upon the foliage were quickly noted.

In this experiment the ammonia and cyanide gases were mixed in the "relay." In order to leave more of the ammonia free to act upon the foliage, it was injected directly into the chamber, where the two gases were less intimately mixed. Upon circulating the gas, strong alkalinity prevailed in all parts of the apparatus, and the atmosphere about the tree was decidedly charged with ammonia. The results were very marked. In a short time the trees wilted; in ten days all the foliage was crimped up, and later all fell off. Even the wood of the more tender branches was noticeably affected.

As *formic acid* is often produced during the decomposition of a cyanide, an experiment was made to determine its effect upon foliage. A solution of the acid was boiled and the vapor was conducted into the

chamber until quite a decided acid reaction was shown by the test of papers. No harmful effect was noticeable. Formic acid and ammonia were next separately introduced, the ammonia being in very slight excess. In this case also no noticeable harm was done.

INFLUENCE OF TEMPERATURE.

It is to be regretted that the normal temperature (50 degrees to 65 degrees Fahrenheit) during the experiments was much lower than that which would be met with in actual field work; and therefore the injury done to the seedlings would not be so marked as in the latter case.

An attempt was made to raise the temperature within the chamber up to that of a warm summer's day in the orange districts. The range of temperatures used was 95 degrees to 105 degrees Fahrenheit, but the outside temperature being low, as soon as circulation began, the moisture from the interior of the chamber given off during the rise in temperature was partially drawn in and condensed in the tubes during the circulation, and thus absorbed the ammonia, as well as part of the hydrocyanic gas.

Notwithstanding this partial removal of ammonia by absorption, the results showed that these high temperature treatments produced more injurious effects than similar treatments at lower temperatures.

CONCLUSIONS.

From the foregoing experiments we are led to believe that *ammonia* has been the fruitful cause of the injury to the trees subjected to the treatment under discussion. Under this view of the case, the beneficial effects of the use of carbonic acid gas would seem to be due to its power of neutralizing the ammonia, with the formation of carbonate of ammonium, when the two gases come together. And, furthermore, the failure of the carbonic acid to *completely* preserve the tree during the hot part of the day follows from easy decomposition, by heat, of the carbonate of ammonia, which does not occur during treatments at lower temperatures. Even the formate of ammonium, produced in a preceding experiment, would be decomposed in like manner, and some ammonia set free to act upon the foliage.

MODES OF PREVENTING INJURY.

There are, then, two means of averting the injury to foliage: *first*, by the use of the dry salt; *second*, by the use of proper appliances to absorb the ammonia as it leaves the generator.

In the first case, viz.: using the dry salt, only a minimum amount of ammonia is produced during a strong reaction. But it was shown that it is quite impossible to handle the dry salt so as to insure complete action of the whole dose; and, furthermore, the slowness of the action prevents the rapid injection of the gas into the tent. It should be injected rapidly, so that complete circulation of the gas about the tree may be established, and the maximum effect produced at once, so as not to make it necessary to increase the time of exposure.

In the second case, viz.: the use of the solution, the action is rapid, and the injection can take place immediately. But with the use of solu-

tion, the trouble from formation of ammonia comes in; this can be obviated by the use of proper apparatus to absorb the ammonia as it leaves the generator.

The apparatus used in field work can be so modified that an absorbent of the ammonia may be inserted at the exit of the generator, and connected with the general circulation. Such an apparatus can be made of a cylinder filled with loose pumice stone, over which sulphuric acid is poured from time to time. By this means a large surface is exposed for the absorption, and it can be readily so arranged that, with slight trouble, the surface of the pumice stone can be resaturated with sulphuric acid.

This apparatus, if interposed in the tubes through which the general circulation takes place, would interfere with the rapid passing of the volume of air which is to accomplish the agitation within the tent. In order to avoid this obstruction, a secondary circuit may be connected with the general circulation, to be used only when the generator is to be cleared of the last portion of the hydrocyanic gas. The pressure of the gas alone, during its evolution, is sufficient to force its way slowly into the general circulation. Thus the general circulation and agitation remain independent of both generator and drying-chamber. The secondary circuit carries a volume of air from the blower through the generator and through the drying-vessel, and thence discharges into the general circulating pipe. This is accomplished by placing a hinged valve at the exit opening of the blower into the general circulating tube, in such a manner that the current of air may be passed either forward or backward by reversing the motion of the blower. The air may be forced by the backward movement through the secondary circuit.

By application of either of the above methods the use of carbonate of soda can be avoided, and the work somewhat simplified. There will be far less residue in the generator, so that several treatments may be made without emptying the latter. Besides this, there will be a decrease in the expense through the omission of the carbonate and the correspondingly less amount of sulphuric acid required.

It will be necessary to demonstrate by further experiments whether the use of the cyanide alone will be so effective against the scale as when combined with carbonic acid. The best results of field experiments have accompanied the joint use of carbonate and cyanide, although it is maintained that the cyanide alone will produce as fatal effects upon the insect.

Some tests were incidentally made to note the effect of the gas upon the scale insects *Aspidiotus* and *Lecanium*. Branches of laurel and acacia infested with these scales were placed in the chamber during the treatment of trees at high temperatures. The effect, in some instances, was complete, while in others 90 per cent of the insects were killed, and the remaining 10 per cent still showed faint signs of life, and may have survived the treatment. Under the proper treatment, this gas remedy will undoubtedly prove as effective on these scales as upon the white scale, against which the remedy was originally intended to be applied.

LIST OF PAPERS RECEIVED AS EXCHANGES, AND KEPT ON FILE IN THE READING-ROOM OF THE CENTRAL STATION.

[The papers in the following list are sent by the publishers in exchange for the bulletins, reports, and various publications of the Experiment Stations. We should be glad to extend the list in the direction of practical publications devoted in part or wholly to agricultural and horticultural work.]

FROM CALIFORNIA.

California, San Francisco.
California Fruit Grower, San Francisco.
Central Californian, Fresno.
Chino Valley Champion, Chino.
Citrograph, Redlands.
Fertilizing Gazette, South Riverside.
Four Corners, Wheatland.
Fresno Weekly Republican, Fresno.
Great Southwest, San Diego and National City.
L'Union Nouvelle, Los Angeles.
Orange Grower, Rialto.
Pacific Rural Press, San Francisco.
Pacific Wine and Spirit Review, San Francisco.
Petaluma Courier, Petaluma.
Press and Horticulturist, Riverside.
Redondo Beach Compass, Redondo Beach.
Rural Californian, Los Angeles.
San José Daily Herald, San José.
Santa Clara Valley, San José.
Weekly Gazette, San Francisco.
Weekly Times-Index, San Bernardino.
West American Scientist, San Diego.

FROM OUTSIDE OF THE STATE.

Agricultural Epitomist, Indianapolis, Indiana.
Agricultural Journal, Montgomery, Alabama.
American Grange Bulletin, Cincinnati, Ohio.
American Rural Home, Rochester, New York.
Baltimore Weekly Sun, Baltimore, Maryland.
Boston Weekly Globe, Boston, Massachusetts.
Fancier and Farm Herald, Denver, Colorado.
Farm and Fireside, Philadelphia, Pennsylvania.
Farm Journal, Philadelphia, Pennsylvania.
Farmer's Home, Dayton, Ohio.
Farm and Home, Springfield, Massachusetts, and Chicago, Illinois.

Farmers' Review, Chicago, Illinois.
Holstein-Friesian Register, Boston, Massachusetts.
Horticultural Art Journal, Rochester, New York.
Hospodár, Omaha, Nebraska.
Landwirth, St. Louis, Missouri.
Louisiana Planter, New Orleans, Louisiana.
Mercantile Exchange, New York.
Mirror and Farmer, Manchester, New Hampshire.
National Provisioner, New York.
National Reformer, Houston, Texas.
New Dairy, New York.
Northwest Horticulturist, Tacoma and Seattle, Washington.
Orange Judd Farmer, Chicago, Illinois.
Popular Gardening and Fruit Growing, Buffalo, New York.
Poultry Bulletin, New York.
Practical Farmer, Philadelphia, Pennsylvania.
Review and Farmer, Pueblo, Colorado.
Southern Cultivator and Dixie Farmer, Atlanta, Georgia.
Texas Journal of Horticulture, Tyler, Texas.
Vick's Illustrated Monthly Magazine, Rochester, New York.
Vorwärts, Toledo, Washington.
Western Breeder, Beattie, Kansas.
Western Resources, Lincoln, Nebraska.

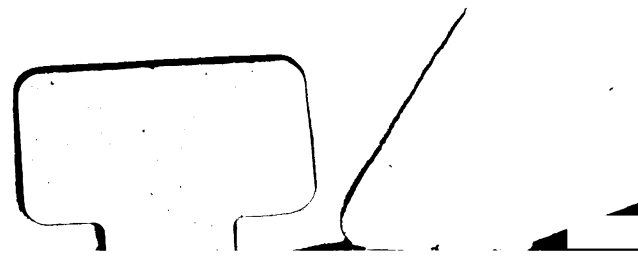
AGRICULTURAL EXPERIMENT STATIONS OF THE UNIVERSITY OF CALIFORNIA,

IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

		Cr.	Dr.
1891.	To receipts from the Treasurer of the United States, as per appropriation for the year ending June 30, 1891, under Act of Congress, approved March 2, 1887		$15,000 00
June 30—	By buildings	$179 05	
	By chemical apparatus and supplies	32 61	
	By furniture	165 30	
	By fencing and drainage	174 29	
	By freight and expressage	70 78	
	By incidental expenses	229 05	
	By labor	5,016 83	
	By live stock	500 00	
	By postage and stationery	32 50	
	By printing	22 50	
	By salaries	5,350 86	
	By supplies	2,035 35	
	By tools, implements, and machinery	424 06	
	By traveling	497 85	
	By water supply	268 97	
	Totals	$15,000 00	$15,000 00

We, the undersigned, duly appointed members of the Finance Committee of the Regents of the University of California, do hereby certify that we have examined the books and accounts of the Experiment Stations of the University of California, for the fiscal year ending June 30, 1891; that we have found the same well and correctly kept and classified as above, and that the receipts for the time named are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file, and have been by us examined and found correct.

A. S. HALLIDIE,
ALBERT MILLER,
I. W. HELLMAN,
Finance Committee of the Regents of the University of California.

I hereby certify that the foregoing statement, to which this is attached, is a true copy from the books of account of the institution named.

J. H. C. BONTÉ,
Secretary of the Board of Regents.